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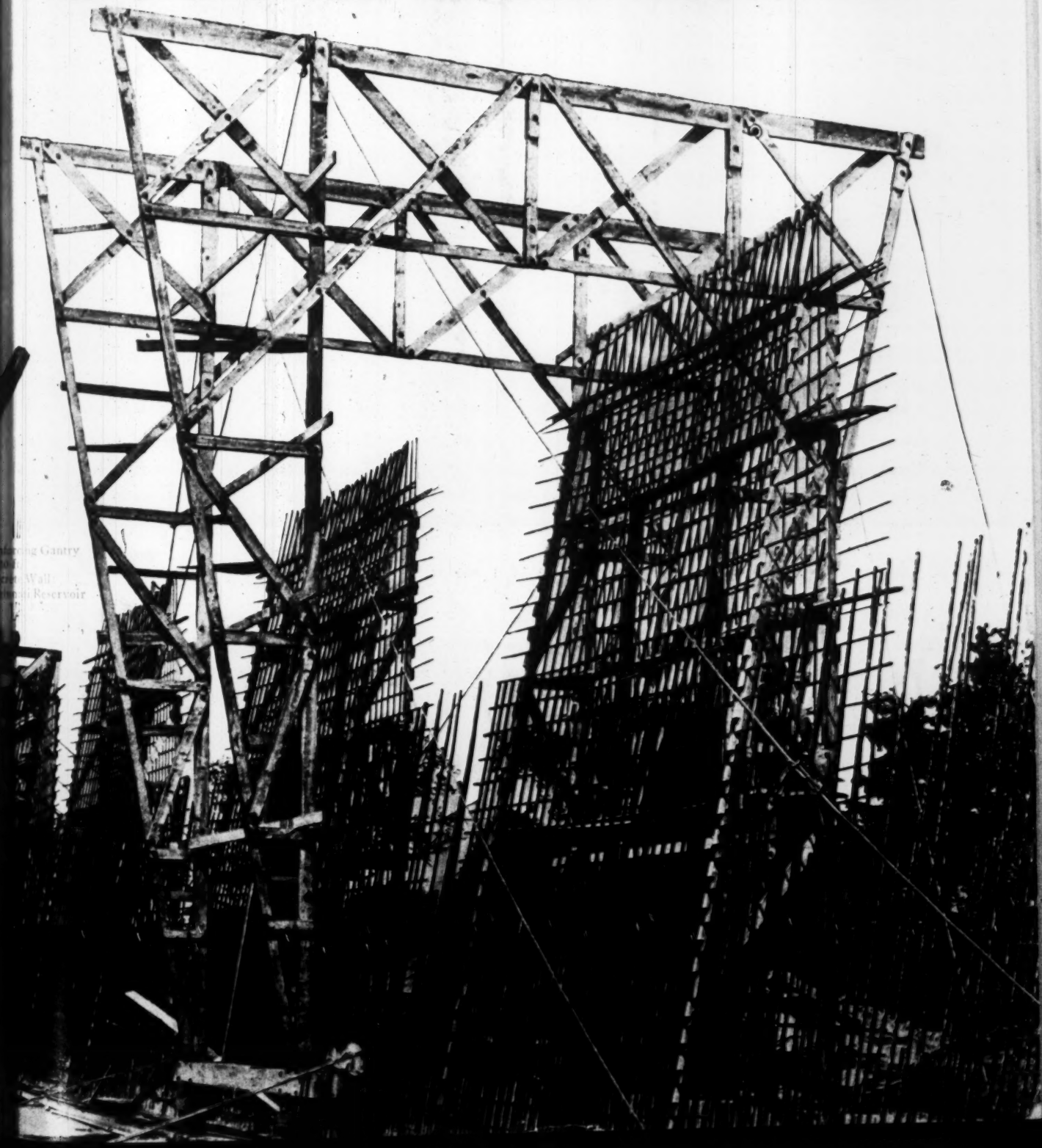

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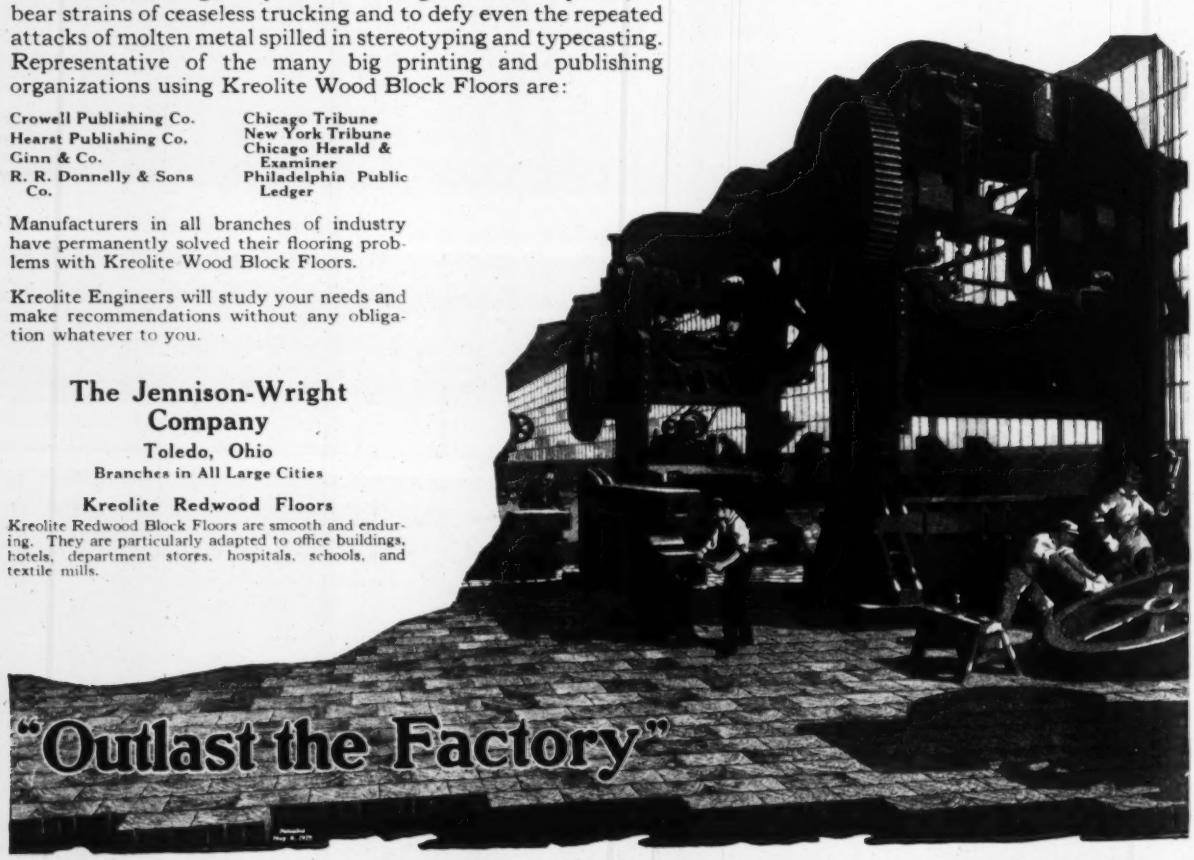

FLOORS

WOOD BLOCK

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 94 NEW YORK, APRIL 9, 1925 Number 15

Queer Simplification

A CURRENT rumor to the effect that those engineers and builders who had been working for co-ordination of federal government engineering activities in the Department of Public Works were in some confusion as to practical policies is confirmed by a bulletin of the American Engineering Council. The Council, rather largely interpreting its authority in its field, says "The engineering profession, supported by architects, the building industry and allied fields, asks that provision also be made for an assistant secretary for public architecture and an assistant secretary for public construction [in addition to the assistant secretary for public domain and assistant secretary for public works provided in the current bill before Congress]. It is proposed to give the assistant secretary for public works administrative jurisdiction over all engineering work by whatever bureau or other instrumentality of the department performed. The assistant secretary for public architecture would be in charge of all architectural activity. The assistant secretary in charge of public construction would direct the entire construction work of the department." This is a queer way to simplify government business, which we take it is the main object of the departmental reorganization. We leave to our readers familiar with any kind of governmental work the picture of the confusion which will arise when there is an effort made to allocate some particular kind of public construction activity between the assistant secretary of public works, the assistant secretary for architecture, and the assistant secretary for public construction. There could hardly be three more overlapping and interlocking functions.

Underground Sewage-Works

A GOOD example of how the engineer adapts his creations to meet local conditions, both physical and financial, is afforded by the 40-m.g.d. underground sewage-works at Canal St. and the Hudson River, New York City. With the hundreds of miles of waterfront swept on the west by the outpouring of the Hudson River and everywhere by immense volumes of salty tidal waters, sewage disposal entirely by dilution, supplemented under exceptional local conditions here and there by partial treatment, is all that has been called for in the past. Presumably it is all that will be needed for years to come, except as more intensive treatment is needed at some of the less favored points. Confining further remarks at this time to Manhattan Borough it may be noted that topography and street layout have led to a multiplicity of waterfront outlets. Most of these serve relatively small areas, but so densely populated as to contribute large volumes of sewage. To remove all the sewage from Manhattan Borough would require an enormous outlay for intercepting sewers, a long outfall and pumps, with heavy capital and operating charges, and with means of final disposal still to be provided. Any considerable degree of treatment on Manhattan Island would require large areas of highly expensive built-up land, besides arousing fear of nuisance. Fortunately in some parts of Manhattan the only sewage treatment needed is enough to remove so much of the suspended solids as can be taken out by fine screens, with possible resort to chlorination of the effluent. Such a screening and chlorinating plant was opened at the foot of Canal St. last week, as described elsewhere in this issue. The screens, chlorinators and pumps are all beneath the street. The percentage removal of solids by the screens just put in use at the Canal St. plant, experience in disposal of the screenings by ejecting them to the surface and carting them away, and data on chlorinating a sewage still containing large amounts of organic matter, both in suspension and solution, will be awaited with interest.

Good Job Roads

AMONG the benefits of the motor truck in construction is that it has directed attention to better job roads. One whose recollection goes back a decade is invariably impressed with the changed road conditions observed on almost any well managed modern construction operation. Planked ways are carried into the pits and close to the shovels, and graded and often surfaced roads run to dumps and stockpiles and outside to the railway or public highway by which materials come in. And here is the point to be observed, it is the half-mile or so of dirt road on the job which cuts down loads and speed and profits. Twenty miles of broad paved highway running to the construction operation will not moderate the misery to the contractor of the half-mile of rutted and soft trail which goes to his stock piles and steam shovels. Perhaps road building operations illustrate this fact oftenest but every class of construction where truck haulage is a considerable operation has its examples. Where there is much job haulage by trucks there is no plant investment more profitable than a good job road.

Toe Scour at Dams

TOE scour is about as universal and persistent a phenomenon as any connected with overfall dams. In natural waterfalls and in primitive dams, the energy of the overfall hollows out a deep pool directly under the falling water. Modern construction, aiming to prevent this excavating effect by providing an apron which deflects the water horizontally downstream, merely transfers this scour to the front edge of the apron. The result is, in cases without number, undermining of aprons and progressive failure of the protective device, often so extensive as to threaten or destroy the dam itself. Costly repairs have been made necessary by this sequence of events; added to the cost of the apron, these expenditures make the debit

account against present practice in toe protection of dams remarkably heavy. It seems clear, then, that the dam apron is an anomaly, since it sets up the very actions which destroy it and which it is designed to prevent. A pioneer discussion of this subject is contained in A. F. Meyer's article in this issue. It is regrettable that the author refrains from citing specific cases of toe scour and its results, since such cases are plentiful; but the engineer familiar with hydraulic matters will have no difficulty in supplying his own illustrations. With these and the general descriptive statements of the article in mind, one easily perceives the principle on which any solution of the problem must be based, namely that the moving energy of the overfalling water must be destroyed before the water reaches erodible ground. Examples of how this is done in some existing structures will at once be recalled, as by the use of steps to break the fall of the water or by the use of large riprap paving below the dam to permit the turbulence from destruction of the water's energy to occur without erosive effect. The solution presented by the author follows a different course. Its application to practical cases should give occasion for much interesting study.

Road Construction Records

FIFTEEN hundred miles of concrete pavement is the road-building stint which Illinois has set itself for 1925. Any practical road builder will realize all the elements of magnitude of this task. It has no precedent. How may we anticipate its accomplishment? Recent newspaper dispatches carried the statement that a hundred contractors, the moment the ground was settled enough and the air was warm enough, were mobilized and waiting to take the field. Already materials and equipment to begin action were on the ground. In this news story we have the indication of the answer to our question. There is in Illinois a trained standing army of state highway department forces and of contractors' forces all prepared for action. Let it be observed that here the contractors' forces are put on a parity with the state highway department forces. This is emphasized because no state has a great road-building organization however well organized and competent and loyal its highway department forces may be unless there is working with it an equally loyal and competent force of prosperous contractors. Illinois has this combination. More correctly it has built up this combination by holding its department personnel together and by giving yearly employment to its contractors. It has created a state road-building business. No state becomes a great road-building state until it does as Illinois has done.

A Momentous Project

ALMOST unnoticed, the first step has been taken toward the ultimate construction of a bridge so far beyond any existing structure in its size as to rank virtually in a new order of magnitude. The legislatures of New York and New Jersey have appropriated a total of several hundred thousand dollars for the preliminary studies for a highway bridge across the Hudson River in the neighborhood of Fort Washington Point, in the upper part of New York City, extending to Fort Lee. A year ago O. H. Ammann published a design for such a structure (*Engineering News-Record*, Jan. 3, 1924, p. 34), showing a suspension span of 3,400 ft. and an eight-line highway deck; as this design was prepared after careful study of the local conditions, it may be accepted as a fairly accurate statement of the problem which the states have now placed before the Port of New York Authority. The new Delaware River bridge, connecting Philadelphia and Camden, has a main span of 1,750 ft., while the three East River suspension bridges at New York have spans of about 1,600 ft. Thus, the Fort Lee bridge will be about twice as large as the world's greatest bridges now existing—a tremendous step forward, in difficulty as well as dimensions. It is true that the difficulty lies more in the detail development of the design and construction than in any basic uncertainties. The feasibility of the suspension type for a structure of this order of magnitude is well recognized; tower, cable and floor construction present nothing more serious than a volumetric duplication or quadruplication of what has already been done successfully. There is, of course, a fair possibility that radical developments may be worked out in the full study of the problem, since at best it will be a gigantic undertaking to build this gigantic bridge. But whatever may be thought of its constructional problem, we believe that the bridge will be even more sensational in its traffic and development effect upon New York and the tributary territory on the west shore. It will initiate New York's extension to the west, on which side it has been walled off by the wide and deep Hudson ever since the New Amsterdam days. This profound change will follow by half a century the city's eastward extension into the quietly vegetating residential city of Brooklyn, brought about by John A. Roebling's work of the seventies. Its effect promises to be quite as far-reaching.

High Speed Surveying

IT IS a significant fact that although the problem of surveying and mapping by the aid of photographs taken from airplanes has been studied for a dozen years, new processes are being brought forward. The problem is extremely difficult and at the same time highly important. Topographic surveys of large areas are desperately slow. During the many years that the government authorities have been at work on the topographic mapping of the United States, they have covered less than half, and this with but indifferent accuracy, as users of topographic maps have experienced. Hopes are entertained of completing the work within the next two decades, and these hopes are the foundation of the recently passed Temple Bill. If high-speed methods of mapping can be developed, and can be shown to have a satisfactory degree of precision, they may prove desirable in a degree not at all measured by relative costs. The subject is of universal interest to engineers, since every department of their work is touched by the surveying and mapping problems. The article in this issue should therefore invite study in wide circles. The difficulty which the new process undertakes to solve may be readily perceived when it is realized that a small group of photographs of the same area, taken from different viewpoints, can be co-ordinated in only one way, and when so co-ordinated, is sufficient to determine every point of the area in question (assuming that the surface has a definite identifiable texture). To transform this fact into a workable process, however, means departing from it in practical working principle. The particular nature of the departure char-

acterizes the various processes that have been proposed. In this particular process, certain differences of elevation measured on the ground are used as the basic data from which photographs are co-ordinated and the positions of other points in the area of view are determined The rapid drawing of contours after the "co-ordination" is accomplished is a particular claim of the process. While some large-scale field demonstrations are cited to support this claim and the associated claims of precision, there are so many complicating conditions and requirements in general survey work that most engineers, probably, will reserve opinion on the scope of application of the process until further field results are obtained.

A Long, Long Trail

WE ARE about to flout a tradition. Disclaiming any personal references whatever, we shall splinter a lance with an ancient champion, virtuously secure in our opinion that he has held the lists too long. We purpose, in short, to hold up to ridicule the unwritten law of the American Society of Civil Engineers that the presidency can only be reached through slow and decorous progress through the offices of director and of vice-president.

Thanks to the emergence in the American Society some years ago of the principle of self-determination, its members are now about to embark on a nine-months' campaign for next year's officers. First, they will be asked to indicate their suggestions as to these officers, and when these suggestions have been counted and published they will be asked to nominate some one of the suggestees, and when these nominees have been duly recorded and broadcasted they will again be asked to select certain of these nominees for the offices to be filled. The gentlemen so denominated, having survived the rigorous selecting and deleting process outlined, will become the officers of the society—at a cost to the society of many thousands of dollars for stationery, clerical help, and postage, to its members of annoyance and unnecessary labor, and to the candidates, or their supporters, of some money and much effort.

This triumph of democracy was insisted upon and adopted to insure the free selection of officers, to prevent what some had contended was the political domination of certain sections and certain blocs, who, report had it, controlled nominating committees and dictated nominees. And so the free and open direct primary was inaugurated.

But the selection of officers has by no means been made the free and open expression of the will of the electorate at any given time, for with the great reform there came down from the past the hoary tradition—no man shall be president until he has been vice-president and every vice-president shall have been a director. That tradition imposes restrictions and promotes maneuvring of the most sinister sort. There is no constitutional requirement as to this royal succession, but the records show an unwritten law. In all its history, the society has had but one president who was neither an ex-vice-president nor an ex-director. It may or may not be significant that that man was that outstanding figure—George S. Morison. In the present century, again, twenty-two out of twenty-five presidents served both as director and as vice-president, and of the remaining three, two had not been directors but were vice-presidents and the other had been a director but not a vice-president.

Thus the record is clear. The precedent is established. It is fairly evident that it will be defended on the ground that experience in the operation of the society is necessary for the man who is to take executive charge for a year. There may be those, too, who would contend that the five years on the board with the quarterly travelings up and down the face of the country and the quarterly or more frequent three-day travailing on the board itself are not only necessary discipline for the prospective president, but are earnest of his interest in the society which is to honor him.

All of which may be so, but see what it means. The members of the society are in effect deciding this month who shall be president of the society some time in the 30's; the man who is selected president this year was marked for that job ten or twenty years ago. And there is still further significance to the practice. It is unfortunate but true that the election to office in a technical society is not a spontaneous tribute to a worthy man. However worthy the man, his friends must electioneer for him. The numerous bulky testimonials now reaching the desks of members are proof of this. Think, then, what the presidency of the society imposes on the individual. It means the acquiescence in, or in rare cases the initiation of, three separate campaigns of candidacy, the first reaching back a decade or so before the time the prospective president takes his office. This in its turn can hardly help but lead to the setting up of a political machine in each of the several districts or among those of similar thought or policy, for the reason of being of a political machine is to insure that its representatives continue in office.

Consider, too, the situation that confronts the society. Under this unwritten but apparently imperative law the members today have to choose their president from among nineteen men. Of these nineteen living ex-vice-presidents, five live in New York City, and therefore by another but quite reasonable unwritten law are barred this year, because the present president is from New York. Of the remaining fourteen ex-vice-presidents, three live in the South, two only live in the West, and the rest are scattered, no more than two to a given city, between St. Louis, Chicago, Pittsburgh, Boston, New York State, and Canada. Reiterating a complete divorcement of this argument from personalities, is it not ridiculous that the immediate choice for presidency of this great professional body should be limited, and, more important, *limited by action taken at odd times in in the past twenty years*, to only fourteen men out of 10,000 who are constitutionally eligible?

We are as appreciative as any one of the desirability of experience in the affairs of the society for a prospective president. But we do protest that this old tradition is not only restrictive of the proper choice of officers of the society but is provocative of political machination which, however inevitable to a degree in every organization, should certainly be discouraged, rather than encouraged by practices which have little validity beyond that of long standing.

Without prejudice, and with no one in mind, we should like to see proposed for president of the American Society of Civil Engineers some one whose only distinction is that he is an eminent engineer who deserves honor at the hand of his associates.

Building a High Reservoir Wall of Reinforced Concrete

Erecting Reinforcement, Handling Forms and Placing Concrete Described With an Account of the Structural Design and the Earth-Handling Operations

CLEVER methods of handling long bar reinforcement and forms for high concrete walls were devised in building the new concrete reservoir for the water supply of the Eastern Hills suburbs of Cincinnati, Ohio. Being 400 ft. square and 30 ft. deep, with the same wall section throughout, the reservoir afforded full opportunity for construction by repetition of operations using mobile plant. This was made the most of and a simple and effective outfit and procedure were worked out. The quantities handled were: Earth excavation 70,000 cu. yd., concrete 24,000 cu.yd., reinforcing steel 1,000 tons and gunite covering 13,000 sq.yd.

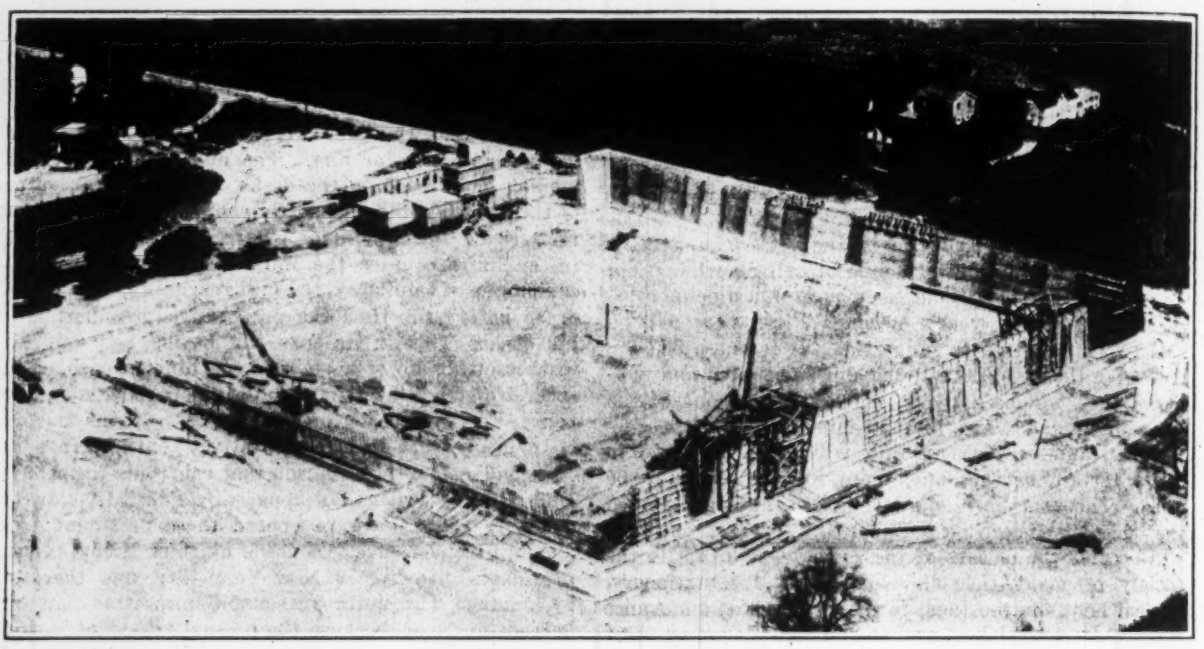


FIG. 1—EASTERN HILLS RESERVOIR AT CINCINNATI, OHIO, UNDER CONSTRUCTION
Top of hill cut down and spread out gives a plateau site for a structure 400 ft. square.

A general idea of the reservoir structure is had from the views, Figs. 1 and 2, and the wall section, Fig. 3. It was designed by the engineers of the water-works department of Cincinnati, J. A. Hiller, superintendent. The location is on a hill whose crest was leveled off by cut and fill as indicated by Fig. 1.

Structural Design—The reservoir consists of a cantilever reinforced-concrete retaining wall 30 ft. high above the top of the footing—forming a square as described above—paved inside with two separate 6-in. layers of concrete reinforced with wire mesh. The outside face of the wall is vertical with spandrel arch indentations and battered buttress piers, Fig. 2. An integral concrete walk near the top of the wall and supported on concrete brackets, Fig. 3, with a precast concrete handrail, extends around the entire reservoir. A box gutter 2 x 2 ft. on the inside edge of the concrete footing, with drains every 200 ft. and weep holes on the inside face, was provided to take care of seepage of the reservoir water through the paving. A concrete key under the footing and tied to the main wall section with shear and tension steel, provides resistance to sliding. A 4-in. mat projecting 1 ft. on each side of the footing, laid directly on the subgrade and integral with the concrete key, was placed as soon as possible after excavation to ensure a dry foundation for footings. Concrete column footings were placed 25 ft. on centers in both directions throughout the interior of the reservoir to provide support for a future covering. A 24-in. inlet was provided at one corner, and a 30-in. outlet at the opposite corner. An office for housing the necessary gages and mechanical equipment was placed against the center of the front wall, and its design was such as to give the same appearance as the wall.

Earth Moving—Broadly the earth moving consisted of clipping off the hill crest and spreading the material out to fill low places and build out the plateau. In detail the sequence of operations to fit in with the construction plan had to be rather complex. First it was required that all top soil under fills as well as over cuts be stripped off. As the plan for wall construction, Fig. 4, involved a fixed mixing plant and a placing outfit which traveled inside along the wall, plant-emplacement fill and cut were next in sequence. Next required was the wall footing cut. There followed excavating within for paving and column footings and finally grading and surfacing the exterior fills to specified contours. As fitting best the several operations the plant selected was a ¾-cu.yd. revolving gas shovel (convertible), a 60-hp. crawler tractor, four 5-cu.yd. trailers, four ¾-cu.yd. wheel scrapers, and a 12-ft. grader. Some teams were used at the start until the trailers were delivered.

The tractor and wheel scrapers were put at stripping

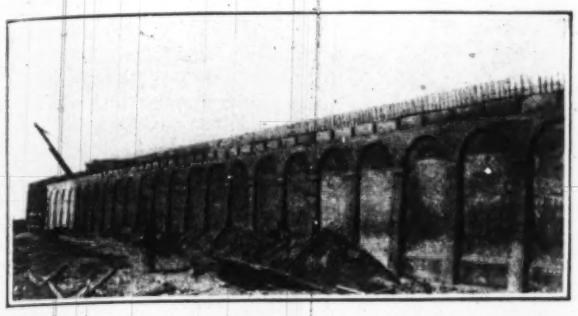


FIG. 2—SPANDREL ARCH DESIGN OF OUTER WALL FACE
When completed a precast concrete ornamental hand rail will crown the wall top.

which was finished at about the time the trailers were delivered. In the meantime teams served the shovel which made first the equipment track cut along the east wall and then returned making the footing cut. Then, served by tractor and trailers, the equipment track and footing cuts were completed along the other three walls. The main interior cut was then made working the same outfit back and forth parallel to the west wall. With the cuts and fills to grade the tractor was hitched to the grader and the fills finished to contour. In general the operations were normal but there were a few of special interest.

The trailers were hooked up in pairs, and while the tractor was taking a loaded pair to the dump the shovel was loading the other pair. Time was lost at first in spotting the empty wagons and in hooking up, but a special drawbar casting was devised to allow greater play in the connecting parts. Five-eighth inch chains were permanently attached to the rear wagon of each pair and as an empty pair was pulled up behind a loaded pair, the chain was hooked to the tongue of the front empty, the loaded pair then being pulled away and the empties spotted. The length of haul where possible was adjusted to the conditions of the excavation and vice versa, in order to make as nearly as possible the time required for the trip of the trailers, equal to the loading time. The main interior excavation was begun by working back and forth on the west side, this being the side closest to the center of gravity of the main embankment. After fills were carried to grade, enough earth was stacked up on the outside of the footing cuts to make the backfill over the toes of the cantilever footings. It is the intention of the contractor to use the gasoline shovel to place this earth in its final position. The keyway excavation in the footing cuts was done with teams and slips as it was considered inadvisable to use a shovel or trencher. The average depth of cut was about 9 ft., the average excavation per ten-hour day a little less than 500 cu.yd. and the labor required was a shovel operator and helper, a tractor operator and two laborers on the trailers.

Placing Reinforcement— The reinforcing steel was delivered bent, with placing diagrams. The size, length and location of the bars in the footings and the walls made necessary special means of support. The first bars placed were the large 1¼-in. bent bars placed vertically in the keyway and known on the job as hairpin bars. These alternated, long and short, 39 ft. 4 in. and 31 ft. 3 in., respectively, and were spaced 6 in. on centers (Figs. 3 and 5). The height of these bars above the footing subgrade (about 14 and 22 ft. respectively) required the use of a temporary support until the lower portion could be incorporated in the keyway concrete.

Frames spaced 10 ft. on centers constructed as shown by Fig. 6 served as self-centering spacers, a means of support and at the same time a scaffold on which the rod-workers could work. The 2 x 2-in. member spanning the keyway was blocked up to the correct elevation on brick bats, and the ends lined up. Two 4 x 4's, with cleats nailed at 6-in. intervals, were placed between every pair of frames as spacers. A strip of concrete 4 in. thick was poured in the keyway to keep the hairpin steel off of earth. A single 1-in. bar was placed at the top of the frame in a horizontal position and the hairpin bars wired to it. A scaffold board spanning from frame to frame near the top made this wiring easy. The frames were cross-braced to secure rigidity. The concrete mat and key was then poured and the frames wrecked, leaving the steel self-supporting.

The necessity for supporting the horizontal steel in the top of the footing presented more difficulties. A

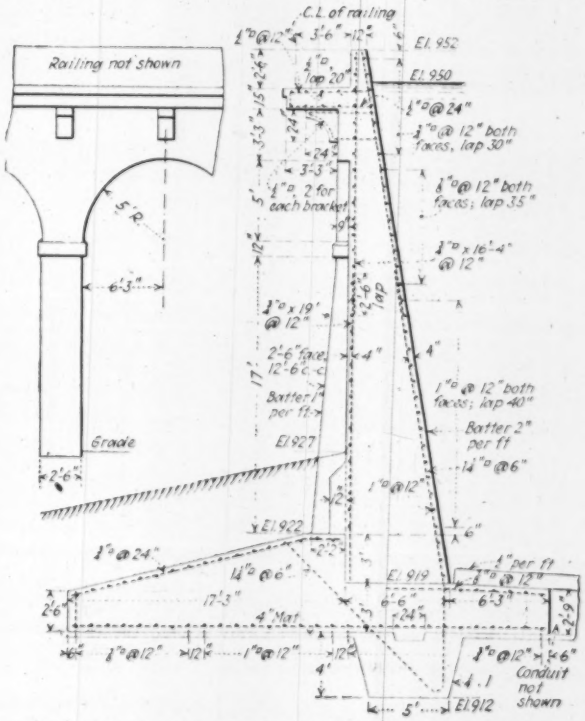


FIG. 3—WALL SECTION WITH REINFORCING DETAILS
This is the detail of the wall shown by Fig. 2. The reinforcement should be noted in conjunction with Figs. 5 and 8.

method was devised, however, of suspending the steel from 4 x 12-in. timbers supported at the two ends by footing side forms, and in the center on a steel angle clamped to the hairpin steel, Figs. 5 and 7. This same device supported the construction joint bulkhead near the center of the wall, and the forms for the drainage gutter on the inside. The steel was suspended from these timbers with wires, and the timbers were spaced 10 ft. on centers.

The horizontal steel in the inside and outside faces of the wall was supported and spaced by means of frames, Fig. 8. Each frame was made of two 4 x 4's, one vertical and the other sloping to give a distance between them out to out of approximately 1 ft. at the top and 6 ft. at the bottom. The two 4 x 4's were sway-braced, with panel distances such as to give supports

for the scaffolds of the rod-workers. Blocks or cleats were nailed to the outside of these 4 x 4's to give the required spacing of the horizontal steel. One of these frames was used at each end of a 25-ft. wall section. Two intermediate 4 x 4-in. supports were provided for scaffolds. A single horizontal rod was placed at the top

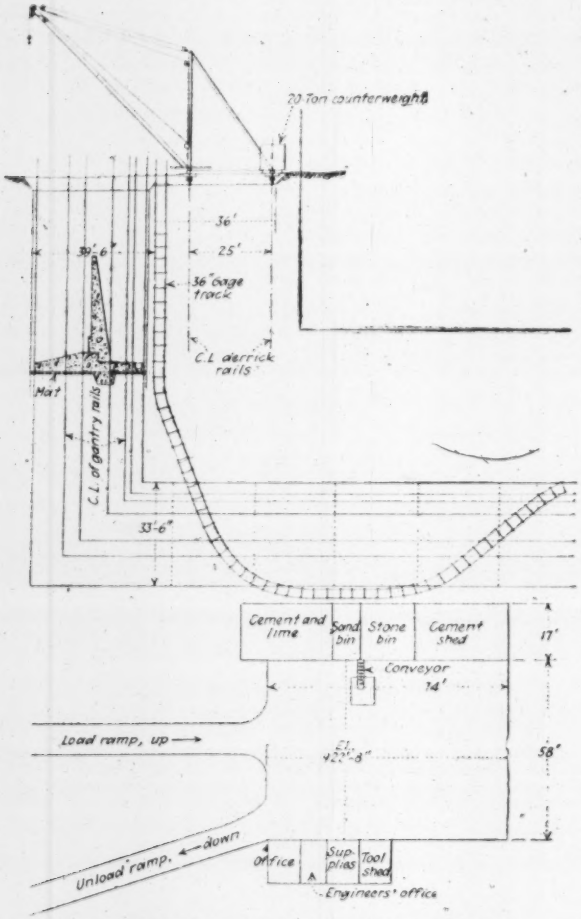


FIG. 4—SKETCH PLAN OF PLANT LAYOUT
Note that track system runs entirely around the reservoir inside the wall and wall building is a repetition of operations with the same plant.

to space the vertical steel, after which the latter was placed, followed by the rest of the horizontal rods. These frames were left in place until the wall forms were placed and then removed. The walls were divided into 25-ft. sections, alternate sections being poured first and the fill-in sections being poured later. Hence the spacer frames were needed only for the first sections, as the horizontal steel projected into the filler sections for splicing.

Form Placing—All forms were made in panels so as to be used repeatedly. The wall panels were made 25 ft. long, the outside vertical form being 26 ft. high and the inside battered face 29 ft. high. As it was decided to pour the concrete only as high as the under side of the walk way, and pour the walk and top of the wall later, the main wall panels were brought only to this height.

The panels for both faces were built of 2-in. tongue-and-groove lumber with 4 x 4-in. studs 18 in. on centers and 6 x 8-in. wafers 3 ft. on centers. The soffits of the

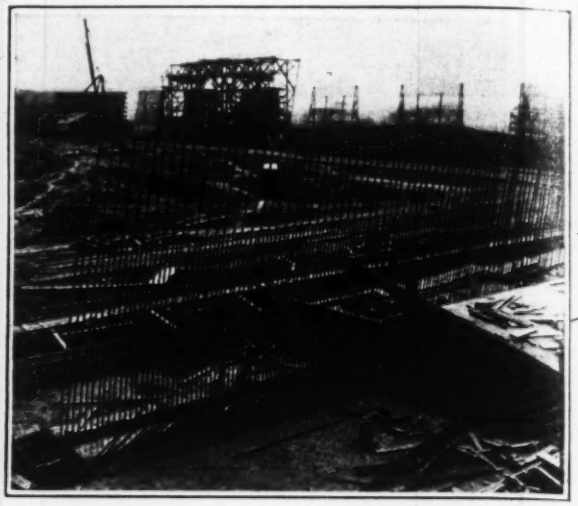


FIG. 5—PUTTING IN WALL FOOTING
Note the footing mat, the core wall concrete holding the hairpin rods and the footing form and reinforcement.

spandrel arches were lined with metal to give a smooth surface. The forms for the buttresses and soffits of arches were chamfered 1 in. to the foot to allow easy withdrawal of forms. Beveled wood sills were grouted in place on top of the footings perfectly level, as bearing plates for the wall panels. This gave the line and elevation of the bottom of the panels, making it necessary to line them only at the top. The bulkheads for the walls were made in sections, two outside sections from the back sides of the horizontal steel to the outside walls notched for the steel, and one center section between the two layers of horizontal steel. The bulkheads were braced against bulging by means of walers spanning between and anchored to, the tops of the 6 x 8-in. walers of the main wall panels. The wall panel

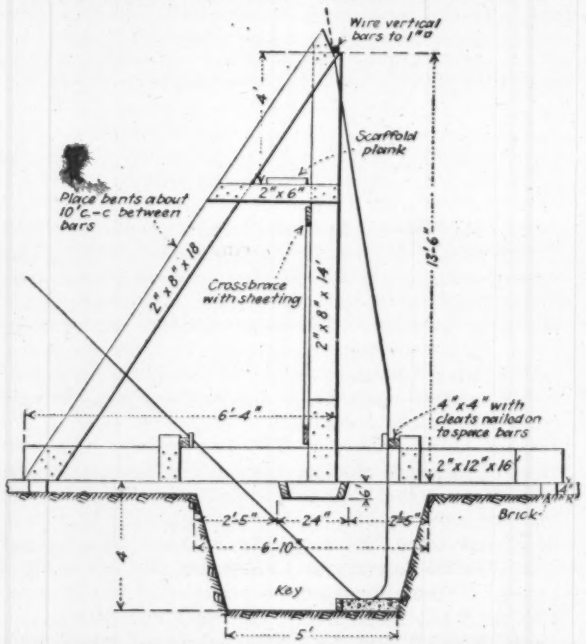


FIG. 6—SCAFFOLD BRACE FOR HAIRPIN RODS
These braces hold the rods until the core wall concrete is poured and holds them upright as shown by Fig. 5.

forms were spaced and tied together with ¾-in. cone nuts and rods. These rods were spaced 3 ft. on centers vertically, and horizontally according to the pressure of the concrete. These rods were left in the wall.

The straight-faced wall panels were built on the job, and the arched and buttressed faces in the mill. Three complete sections were built and each panel will be used 21 times before the completion of the job. The three sections were set up so that they formed alternate sections, were poured and moved ahead to form new alternate sections, or fill-in. sections. Each panel was so designed that it could be used for a new or a fill-in section. The tops of the wall forms were drawn to line and held in place during the pouring by means of cables and turnbuckles.

The forms for the walk way and wall above were also built in panel form. Knee-braced brackets spaced about 3 ft. on centers and anchored to the concrete wall below by means of ¾-in. bolts and cone nuts using the ¾-in. tierods, already in the wall below, were used to support the walk way. The wall form for the back of the wall above was anchored similarly to the existing ¾-in. tierod, and the opposite face tied to it. These forms were hoisted to position and lowered to the ground by means of A-frames, mounted on the wall one at each end of the panel, and blocks and falls.

The footing forms, including the two side walls, the gutter walls, the construction joint bulkhead, and all necessary transverse bulkheads, were made in panels, Figs. 5 and 7. The two side walls were braced against earth banks, the two wall forms for the gutter one against the other, and the construction joint bulkhead was suspended from and braced to the 4x12-in. timbers.

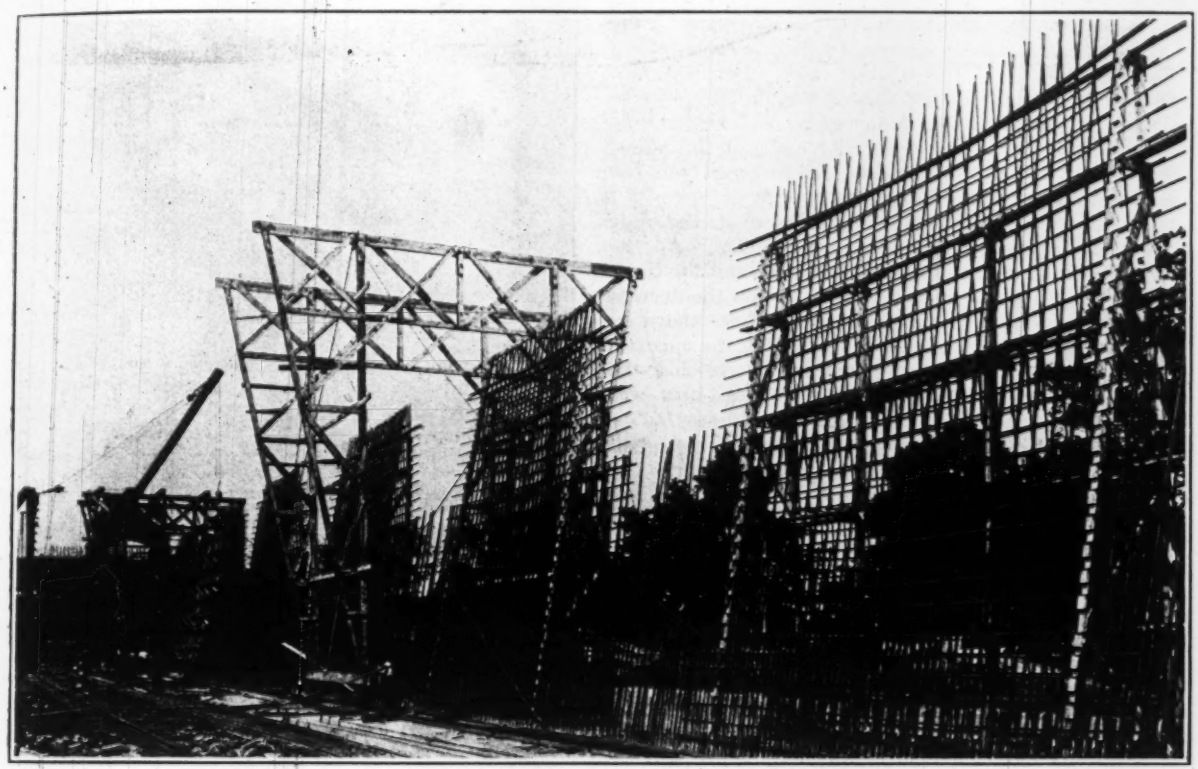


FIG. 8—WALL REINFORCEMENT ERECTED
Observe the frames for holding and spacing the horizontal rods, the form gantrys in the middle distance and the pouring gantries in the background.

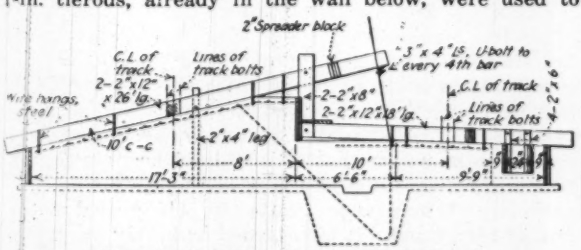


FIG. 7—DETAILS OF FOOTING FORMS
As shown by Fig. 5 these forms hold the reinforcement as well as mold the concrete.

The equipment used on the formwork was a ten-ton traveling stiff-leg wood derrick, Fig. 9, and a wood traveling gantry. The gantry was used exclusively for placing, wrecking and moving the nine-ton wall panel forms. It was equipped for raising, lowering and swinging panels to and from the wall in the following manner. Four trolleys running on I-beam tracks, placed transverse to the wall, supported chains with double-acting screw jacks inserted about midway of their length. The chains were provided with hooks at their lower ends for fastening to the tops of vertical angles in the wall panel forms. The gantry was mounted on double-flanged wheels which ran on light rails one on either side of the wall. It was moved by means of blocks and falls, and also by simply prying with crowbars under the wheels. Where it was necessary to turn the wall panel sections around the four corners of the reservoir, the stiff-leg derrick was used. This derrick was also used to swing the gantries around the corner.

The work of wrecking and moving wall section forms was done mostly at night in order that the job might be expedited, and to avoid the necessity of having to move wall panels past the concrete gantry while pouring concrete. The pulling of the outside wall panel forms presented a difficulty due to the adhesion of the buttress and spandrel arch forms to the concrete. A special device was used. Near each of the four corners of a panel, two 4-in. I-beams about 3½ ft. long were placed side by side in a vertical position and each end bolted to a waler. The bolts ran through the entire panel with the heads seating on the inside face. Opposite the centers of the pairs of I-beams, 8 x 8 x ⅜-in. steel plates were inserted in the forms, flush with the inside face and forming a part of the forms. After the concrete was poured and the panels ready to be removed, double-acting ratchet jacks were inserted between the plates and I-beams. The form was then jacked away from the concrete wall using the four jacks at once.

The turning of the traveling derrick at the four corners of the reservoir was also a problem. All the pig iron counterweight was first removed, and the track was swung a little to curve in the direction the derrick was to be turned. The derrick was then run ahead on the curve, and the track behind it swung in the opposite direction. The derrick was then run back, and the process repeated until the complete 90 deg. turn was made.

Concrete Placing—The view Fig. 1 and the plant plan Fig. 4 show the mixing plant arrangement. The mixer is a 28-S. From it a narrow-gage track was laid inside the wall footings making a complete circuit of the reservoir, and curving at the central plant so as to run directly under the discharge of the mixer. Tractors mounted on car wheels and pushing four-wheeled flat-cars on which were placed bottom-dump concrete buckets of one-batch capacity, transported the concrete from the mixing plant to point of final deposit. Three buckets and two tractors and car units were used. The concrete in the wall footings was placed by means of the gasoline shovel with a 50-ft. boom attachment, and that in the walls by means of a traveling wood stiff-leg derrick in connection with two wood gantries with sloping wood platform hoppers.

Two wood gantries were used in pouring walls, Fig. 9. One was placed on each side of the form gantry so that the latter could work undisturbed regardless of which side of it concrete was to be poured. These gantries were designed similarly to the form gantry except that a sloping platform hopper was suspended from the top beam of each. The platform had a slope of about 3 in. to the foot, and the lower-edges centered over the top of the wall forms. Three telescope chutes were connected to the lower edge of each platform, so that the concrete could be deposited at will in either end or the middle of a wall section. These gantries running on the same rails as the form gantries, could be moved to any position over the wall by means of blocks and falls or crowbars.

The maximum output of the entire mixing and placing equipment taken as a unit was 35 cu.yd. per hour. An average of 250 cu.yd. per day was held for four consecutive weeks, and pours of 350 cu.yd. per day were not uncommon. The average consumption of materials per day was two cars of cement, three cars of sand, and six cars of crushed stone.

Personnel—As described the plant and methods were devised by the contractor, the Max Penker & Sons Co., Dayton and Cincinnati, Ohio. The officers are Theodore Penker, president, Irwin Penker, vice-president, and W. V. Schmiedeke, chief engineer. By these gentlemen was supplied the material from which this article was prepared.

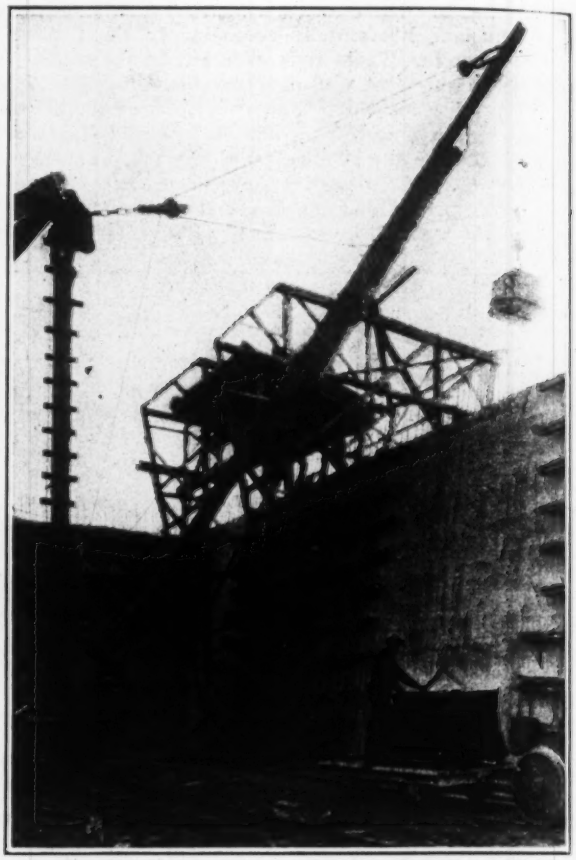


FIG. 9—WALL FORMS AND CONCRETING DERRICK

Four Wilson Dam Power Units Installed

Installation of the four main units of the power generating machinery at the Wilson dam practically has been completed, General Harry Taylor, the Chief of Engineers, reported on March 16, on returning to Washington from an inspection visit at Muscle Shoals. While the switch board is not ready, it will have been completed by July 1 and 120,000 kw. of power will be available at the end of the dam on that date. No steps have been taken to provide transformers, as Congress has made no provision for the possibility of disposing of any portion of the power at a distance. Before leaving Washington after the inauguration for a short vacation trip, the Secretary of War stated that he had given no particular consideration to the problems which must be worked out because of the failure of Congress to make definite disposition of Muscle Shoals. Secretary Weeks had stated some months before that he would not hesitate to make temporary disposition of the power under his custodial authority. There is no reason to believe that he has changed his mind. It is regarded as highly improbable that he would allow the plant to stand idle when the power could be sold readily for more than $1,000,000 anuually.

Concrete Pavement Reinforcement Logically Designed

Construction and Costs of "Rational" Design of Concrete Pavement Discussed Jan. 10, 1924, in "Engineering News-Record"

By George D. Burr
Assistant Engineer, King County, Seattle, Wash.

A RATIONAL method of pavement design, presented by the writer, was discussed in *Engineering News-Record*, Jan. 10, 1924, p. 78. With actual experience in constructing pavement of this design and with some months' successful service of the pavement it may be interesting to note the results. It is also desired to clarify some features of the design which were confused or misunderstood in the original discussion.

The views Figs. 1 and 2 indicate the difficult nature of the portions of the highway that were reinforced. These views were taken in November, 1924, about six months after the pavement was placed in service. No cracks or signs of distress had developed in the reinforced sections, although numerous slides of the type shown in Fig. 2 had occurred. Some of these slides brought 2,000 cu.yd. or more of earth with them. The subgrade material is a clay holding a large percentage of moisture.

Only one weight of reinforcing was used on the whole job, this being slightly heavier than the average calculated value, in order to facilitate the handling of the steel. This particular design is shown in detail in Fig. 3. The 20-ft. length panel was adopted for two reasons: (1) The subgrade was of such a nature that

FIG. 1—TYPE OF LOCATION OF RATIONALLY DESIGNED PAVEMENT

local settlements were liable to occur, and (2) the 20-ft. sections or mats were easily tied together at some point remote from the mixer and carried as a unit to the subgrade.

When once on the subgrade the temporary bulkhead was placed and the whole slab was poured from one position of the mixer which was equipped with a 20-ft. boom. The stirrups *G* and *H* in Fig. 3 were employed primarily to give the mats stiffness and to insure the placing of the steel in the correct positions. They do add an immaterial amount to the strength of the slab.

The general method of handling the reinforcing was as follows: The steel was delivered at points along the grade separated not more than three stations. When the mixer had passed one of these points, a frame such as shown in Fig. 4 was erected on the pavement after it had obtained its final set. The steel was then tied into mats which were stacked ready for use. This operation could have been done at points alongside the grade if there had been suitable places. Six men with three poles picked up a mat, carried it to the subgrade and placed it in position. The organization of the crew

FIG. 2—TYPICAL SLIDE ON HIGHWAY SHOWN BY FIG. 1
The subgrade was clay and some of these slides amounted to 2,000 cu.yd.

at the mixer was the same in all respects as if no reinforcing were being used.

The cost of handling the steel on the first 73 reinforced slabs placed was as follows:

Item	Cost
Foreman 8 hr. at $7 a day	$7
Labor 48 hr. at $6 a day	36
Labor 184 hr. at $5 a day	115
Total cost (30,660 lb.)	$158
Total per pound	$0.0052

It must be borne in mind that this cost includes the setting up of the frame, tying, carrying and placing the steel mats. As this was the first reinforcing of this type handled, there was some lost motion, and it is anticipated that even this small cost can be materially reduced. The contract price for this steel was $0.06 a pound in place.

Clifford Older, then state highway engineer of Illinois, in the Jan. 10, 1924, issue of *Engineering News-Record* makes the following statement regarding the rational system of pavement design:

"The bearing of these tests (tests by Illinois State Highway Commission) upon Mr. Burr's discussion seems to indicate that this assumption 1 (that the subgrade is uniformly elastic up to the limit of the bearing power used) is decidedly unsafe for at least certain types of subgrade soils; and that, granted assumption 1 could be used, the method suggested in assumption 2 (the subgrade bearing power is determined by using a bearing block at least 5 sq.ft. in area, and is the reaction obtained when the deflection of the subgrade is 0.12 in. under the point of application of the load) for determining the subgrade bearing power is so uncertain that results based thereon would be of little value." This statement is inconsistent with Mr. Older's own work which is reported on page 196 of the *Transactions* of the American Society of Civil Engineers for February, 1924, where one will find a chart showing the "Soil deformation under repeated loads of 6 lb. per sq.in. (864 lb. per sq.ft. intensity)." The remarkably uniform elastic qualities of the soil tested will be noted. Such slight permanent deflections as are found are uniform over the entire slab and so introduce no flexual stresses. Highway loads are moving and consequently the entire

area of the slab is progressively loaded with a uniform intensity which causes a uniform progressive settlement, if such occurs, over the whole slab area. Thus no flexual stresses result from this slight progressive settlement. The elastic deformation, only, of the subgrade results in stress in the pavement slab. The same phenomenon is shown in the "Report of Highway Research at Pittsburg, California," on page 88. Thus it is shown that for the purpose of computing stresses due to traffic, the subgrade may safely be treated as uniformly elastic up to some definite bearing power.

A. T. Goldbeck, chief of the Division of Tests of the Bureau of Public Roads, is justified in remarking that "It is not stated by Mr. Burr what width of strip along the edge is considered effective in carrying the wheel load." This, of course, should have been mentioned. This width is a function of the elastic properties of the pavement slab and the subgrade. In the design herewith shown it is 30 in., or the altitude of the assumed parabola of contraflexure was used. Further investigation has convinced me that this is too great a width. Perhaps 18 in. would be a better width to use for the assumed beam, due to the greater concentration of stresses along the edge of the slab. Therefore instead of spacing the steel at distance of 5, 7 and 12 in. apart from the edge inward, I would use 4, 4 and 4 in.

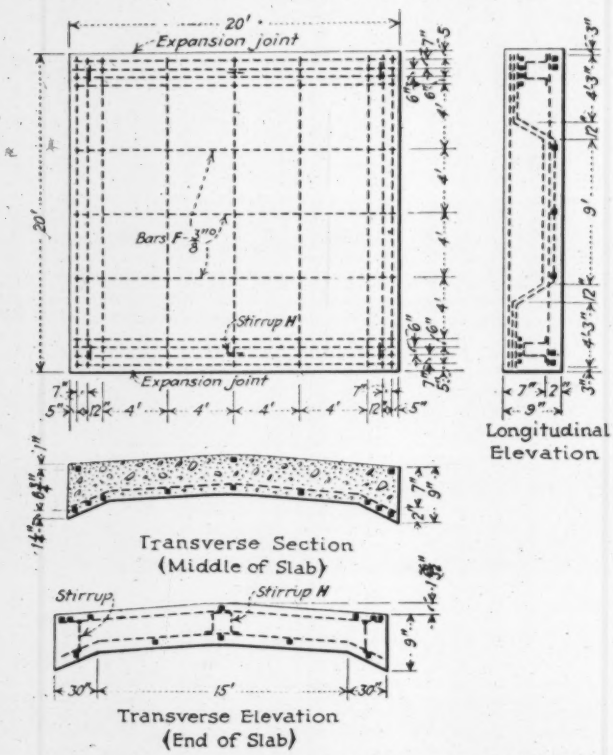


FIG. 3—REINFORCEMENT FOR SLAB 20 FT. SQUARE
Details of reinforcing omitted. The total was about 430 lb. per panel and 21.02 lb. per lineal foot of slab.

Mr. Goldbeck further remarks that "The matter of the effective width over which the wheel loads may be considered as carried likewise has not been stated." This is true in part. It is true that the total distribution of the load on the subgrade has not been defined. However, the portion of the load distribution which causes maximum moment is that between the points of contraflexure. This portion of the load distribution has been carefully defined and means of obtaining the moment shown. The exact analytic distribution of the load on an elastic subgrade acted upon through an elastic slab has never been developed to my knowledge.

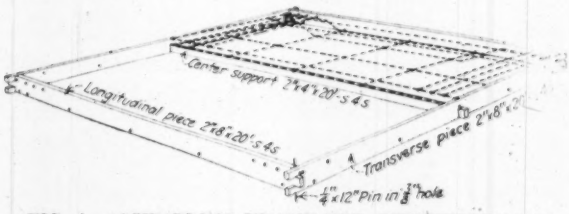


FIG. 4—ASSEMBLING FRAME FOR REINFORCEMENT

C. W. Pantke, in *Engineering News-Record*, Nov. 27, 1924, p. 88, has given the most precise solution of this problem. It must be remembered that Mr. Pantke's solution applies only to a beam of negligible weight and of negligible width. Neither of these factors is negligible in the case of a pavement slab. It may be that this method could be expanded to beams of a material width (i.e. slabs), and of material weight. The method given in *Engineering News-Record* Jan. 10, 1924, of computing the distribution of the load on the subgrade is on the side of safety, is simple and is easily applied, although it is admittedly empirical.

In regard to the use of a center longitudinal joint, there is not much to be said. Clearly there is some width beyond which it is uneconomical to use a single integral slab. This width is influenced by the elastic properties of the concrete and subgrade, the strength of the concrete and subgrade, the climatic conditions, the loading and various other factors, in a manner so complicated that there is at present no definite answer. The use of a center joint introduces two new edges and four new corners, which are potential sources of weakness. Dowel bars are far from efficient or satisfactory. Deforming the edge so that shear is transmitted from one half to the other is only partially effective. Therefore one must give careful thought to the relative cost of reinforcing to resist the transverse stresses or of strengthening two additional edges and four additional corners. In a 20-ft. width of slab the cost is almost the same. The choice depends purely on climatic conditions, and the probability of local settlements of the subgrade. In my opinion the climate of the Puget Sound country is not such that a center joint is warranted in a reinforced slab.

The steel in Fig. 3 is admirably situated to resist temperature stresses. In general if a slab is properly reinforced to resist traffic stresses it probably is well designed to resist temperature stresses.

In view of the foregoing, there has yet to be found a serious fallacy or a noteworthy improvement on the logical system of reinforcing pavement slabs as outlined in *Engineering News-Record*, Jan. 10, 1924.

Colorado Silt Comes from San Juan River

The results of the survey of the deep, winding canyon of the San Juan River, and of the nearly uninhabited arid country adjacent to it, made a few years ago by a party of engineers of the U. S. Geological Survey, have been published in water supply paper 538. The river is always turbid and at times it carries so much silt as to be almost a river of mud. The engineers estimate that a large percentage of the silt of the Colorado comes from this source.

High-Velocity Discharge of Overfall Dams and Forms of Spillway Profile

Ogee Form Found Wrong in Theory and Defective in Practice—High-Velocity Discharge Produces Eddying at Foot of Apron—Apron Scour Common—New Form of Spillway to Eliminate Scour

(*Copyright, 1925, by Adolph F. Meyer*)

BY ADOLPH F. MEYER
Consulting Engineer, Minneapolis

IT WOULD be interesting to know whether the many engineers who each year use the ogee spillway profile on dams, in spite of the well-nigh universal failure of that profile to perform its intended function, have any other reason for adhering to this design than that it is the time- and textbook-honored one. That these engineers have the support of prominent authorities on the subject is evidenced by the following quotations from well-known textbooks, the first published in 1923 and the other two in 1917:

"This curve (referring to the ogee) will also cause the water to be discharged in a horizontal direction, protecting the bed of the stream against undercutting and erosion at the lower end of the toe when severe floods are passed."

"Except for low dams, small maximum discharges, and the best rock foundation, a fillet or 'bucket' should be provided at the toe of the dam to deflect the sheet of water to a horizontal direction."

"It is frequently desirable to give the lower face of the dam a curved outline, in order to guide the water smoothly over the dam, and deliver it approximately tangentially to the stream bed, and in extreme cases, a series of baffles to destroy the velocity resulting from the overfall is desirable."

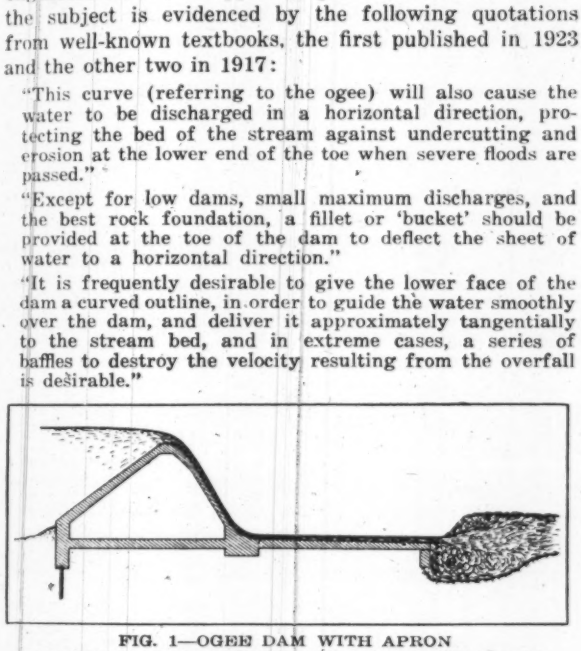


FIG. 1—OGEE DAM WITH APRON
Smooth high-velocity discharge below dam and destructive eddy at foot of apron.

Opposed to these views, however, is this statement in another volume which appeared in 1917:

"Professional opinion seems now to be veering around in opposition to the 'bucket' or curved base of the fore slope which is so pronounced a feature in American overfall dams. Its effects are undoubtedly mischievous, as the destructive velocity of the falling water instead of being reduced as would be the case if it fell direct into a cushion of water is conserved by the smooth curved surface of the bucket."

About seventy-five years ago the late Colonel (then Lieutenant) Dyas, reporting on a project in India, stated, "We have but one ogee fall and that one has given us more trouble in repairing it than all the rest together." In reviewing this report the superior officer stated, "I believe many naval officers in this country have doubted whether the ogee, the figure commonly given to overfalls, is the best that could be desired for the purpose. The violent effect produced at the tail of the fall, and the sharp action of the water on the ogee itself, are generally sources of trouble; but the difficulty of departing from a given form, sanctioned by custom, without good data derived from actual experiment, has probably prevented any change. The vertical overfall recommended by Lieutenant Dyas resembles the operation of nature, and is well worthy of a trial." This statement was made nearly three-quarters of a century ago, yet the ogee spillway is as

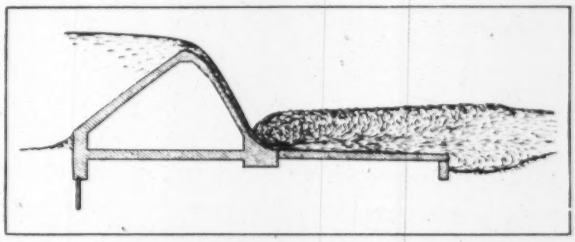


FIG. 2—APRON PLACED BELOW RIVER-BED LEVEL.
Turbulence usually extends beyond apron.

popular with the engineer as ever. The man who pays the bill has probably accepted the ogee as a necessary evil!

Wherever the old rock-filled timber-crib mill dams, built on glacial drift foundations with vertical downstream faces and flat upstream slopes, have been replaced with masonry structures of the ogee type, the overfalling water has done exactly what the ogee profile was calculated to prevent. It has undermined structure after structure, until the annual cost of apron repairs and strengthening has reached an appalling sum.

That the ogee profile should have been almost universally accepted in the face of almost equally frequent initial failure to serve its purpose seems almost incredible. Yet the tremendous amount of energy contained in the flood-water falling over spillways has received little recognition in the description and discussion of dams in our technical literature. One looks in vain in most articles on dams for a statement of the principles underlying the adoption of given profiles, of given lengths and thicknesses of aprons, and of tight or open-jointed apron construction.

When the initial apron structure fails, as it usually does, it is replaced with a more massive and extensive one. If this too fails, still more concrete, cribwork or rock protection is placed, without regard to cost, until the force of the overfalling water can no longer displace the ponderous masses interposed in its path, or reach with its eddies to the outer limits of the protective works and undermine them. Yet, in most cases, the hole which the water gouged out, if perpetuated and limited with lining material, would have served as a far better and less expensive barrier to the destruction of the dam than the concrete and rock with which it was filled.

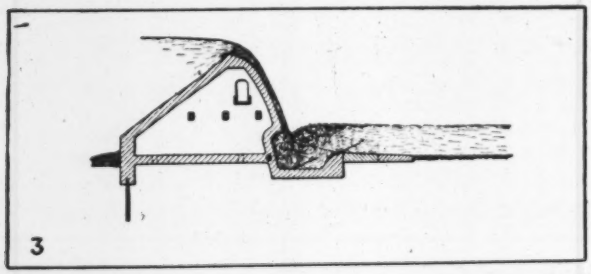
Before a dam has been constructed in a river the

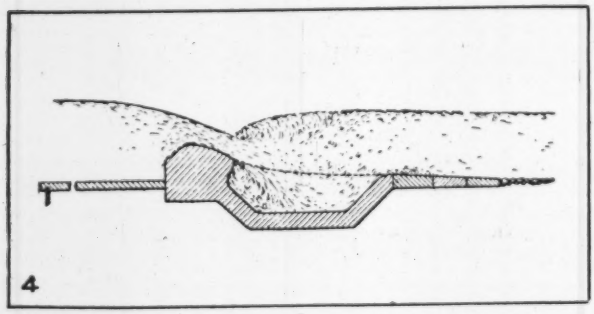
stream of water flows along in the given channel at gravity-imposed depth and velocity. Putting aside hydraulic jump formulas for the moment, doesn't it require some stretch of the imagination to conceive of the swiftly moving water deflected downstream from the curved bucket of the ogee spillway dam, being transformed into that selfsame, leisurely-moving, natural stream without the help of outside forces? The combined fall of probably miles of channel has been concentrated at the dam. Frictional resistance of stream bed has been reduced and therefore a great surplus of energy has been stored which becomes kinetic as the water passes over the dam.

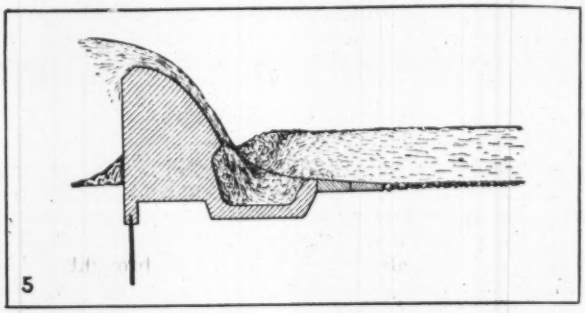
At the foot of the fall this excess energy must be destroyed and the natural regimen of flow re-established. The mere recognition of this fact should point toward the desirability of at least *lowering* all protective aprons below the natural river bottom; yet how seldom has this been done.

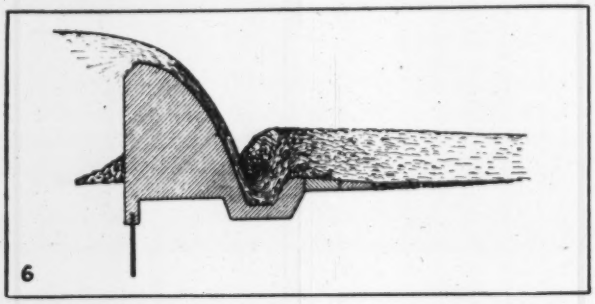
At most spillway dams the depth of the natural stream is not sufficient to supply the static back-pressure necessary at all discharges to overcome the dynamic pressure which the overfalling water is capable of exerting. In all such cases the overfalling water, deflected into the horizontal direction by the curved bucket of the ogee spillway, moves at high velocity over the flat apron. It matters little whether this apron is 50, 75, or 100 feet long. The amount of kinetic energy abstracted from the water by friction on the apron is normally very small. As the water passes beyond the end of the apron, however, it is attacked by the eddy on its under side (backlash) and quickly brought under control. The jump forms, and soon thereafter the natural regimen of flow is re-established. The river bottom, however, has suffered. This condition is illustrated in Fig. 1.

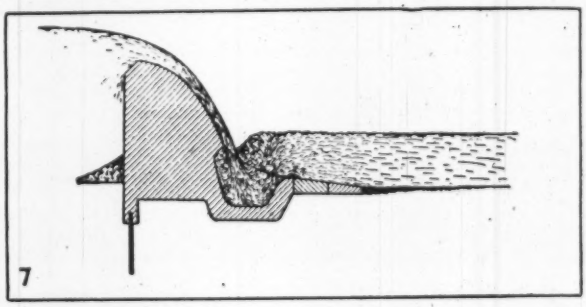
If the ogee spillway is built with its apron lowered sufficiently below the natural river bed to provide the

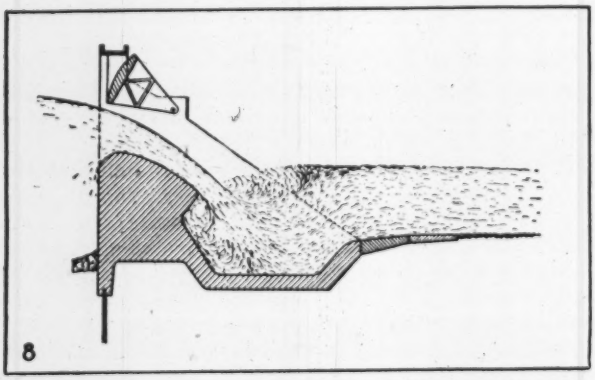


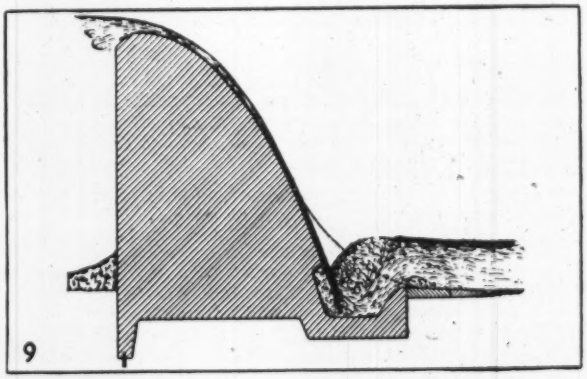












FIGS. 3 TO 9—SPILLWAY DAMS WITH HOLLOW BUCKET
Various applications of a spillway form in which the discharge velocity is reduced by localized double eddy.

required static back-pressure as illustrated by Fig. 2, then the problem appears to have been solved when judged from the appearance of the water level below the dam. Uplift on the apron has been practically eliminated, it is true, but the tendency toward scour has, in most instances, been merely reduced. The line of action of the swiftly moving water is far below the line of action of the static back-pressure, hence a large surface-eddy is formed. Swift under-currents persist far downstream—usually beyond the end of the apron—hence the prevalence of scour even though the apron has been lowered. This condition has repeatedly been observed below ogee spillways. When much debris passes over the dam the eddy formed tends to hold the debris near the dam where it frequently pounds the deck and causes unnecessary wear.

Remedies—Scour occurs below a spillway structure whenever the excess energy of the overfalling water is not sufficiently destroyed before this water reaches the erodible river bed.

It is a matter of common observation that a jet of swiftly moving water led into a pool of relatively quiet water is quickly robbed of its excess energy. If a sheet of swiftly moving water can be attacked by slowly moving water on *both* sides it is brought under control more quickly than if attacked on only one side. At the foot of every natural waterfall there is a pool of water, extended well backward under the crest of the fall by the action of the "back-eddy" or "backlash." Swiftly moving water leaving the bucket of the ogee spillway may flow with little reduction of energy over an 80-ft. apron, but when it begins to flow over the water in the pool scoured out beyond the apron it is quickly slowed up. The most effective way to slow up a moving object is obviously to attack it with forces whose direction and line of action are opposed to the path of the object.

In the following spillway designs an effort was made to utilize these and other fundamental principles. These designs have been originated during the past ten years of study. As they required considerable experimentation at personal expense, the writer felt justified in applying for patent rights on them.

At the downstream toe of a spillway dam the swiftly moving water is capable of exerting a continuous pressure in the direction of its motion equal to its mass times its velocity. In addition, this water exerts a static pressure in every direction proportional to its depth. This latter pressure is usually very small in proportion to the former. To slow up the swiftly moving water and to destroy its excess energy so that it will again flow down the natural channel at the same depth and velocity as before the dam was built, it is necessary to apply to it a static back-pressure at least substantially equal to the dynamic pressure plus the static pressure of the swiftly moving water minus the residual dynamic pressure which the water possesses in a downstream direction after it has been slowed up. The greater the static back-pressure provided and the more effectively it is applied to the swiftly moving water the more quickly will that water be robbed of its excess energy. The depth of water which provides this necessary static back-pressure is herein designated by the letter D. Incident to the determination of the dimension D there is also determined the thickness T of the falling sheet of water, assuming that it has had an unobstructed fall to substantially the level of the center of gravity of the tail-water flow.

The solid curved bucket so commonly used in spillway profiles is replaced by a hollow bucket designed to destroy quickly the excess energy in the overfalling water, and to force the water to assume a downstream direction of flow throughout the full depth of the natural stream within a short distance of the toe of the dam. The top width and the upper portion of the profile of the dam are governed mainly by the path of the overfalling sheet. Near the foot of the fall the sheet of water is led into as nearly vertical a direction as practicable. At a point some distance below the highest level of tail-water in the given channel, the spillway profile is preferably recessed, constituting a shifting of the hollow bucket upstream in order to let the water fall more nearly centrally into it and to permit the formation of the "back-eddy" which attacks the swiftly moving water on the under side and assists in slowing it up.

The downstream rim of the hollow bucket should be placed so as to be a distance at least substantially equal to the before-described dimension D below the tail-water level for *all* spillway discharges. In many cases this will necessitate sloping the short apron and riprap protection upward to the level of the natural river bed. The bottom of the hollow bucket should be placed below the downstream rim of the bucket a distance at least substantially equal to the before-specified dimension T for maximum flood discharge of the spillway; and the bottom width of the hollow bucket should be at least equal to substantially twice the dimension T, for the obvious reason that the swiftly moving water should have sufficient room to move down into the hollow bucket and out again in an upward direction. The lower the velocity of the water as it enters the bucket and the deeper the bucket the more the water is retarded in its downward travel and therefore the wider the bucket should be at the bottom in order to permit uninterrupted retardation.

In low dams and weirs, particularly, the hollow bucket may preferably have a portion extending upstream underneath the downstream face of the spillway to aid in slowing up the overfalling water.

In most spillways the hollow bucket may be reinforced with cross-walls, making the bucket an integral part of the spillway structure. This permits some of the water pressure against the back of the spillway to be carried to the foundation through the hollow bucket, equalizing the foundation pressure.

On account of the upward currents on the downstream side of the hollow bucket, logs and other debris are deflected upward and the tendency for such debris to strike the downstream wall of the bucket is minimized. When used as a part of the hollow bucket, the cross-walls or buttresses also act to deflect logs, trees, ice and other large floating debris downstream. Such debris, however, cannot long lodge in the small eddy next to the dam as it will soon be caught by the downstream currents.

Where large quantities of logs must be passed over a spillway dam instead of through sluices specially provided for that purpose, the hollow bucket may, at slightly increased cost, be widened downstream, dependent upon the length of logs which are to be floated in the given stream.

In Figs. 3 to 9 are shown typical designs of hollow bucket spillways embodying the principles set forth.

Plan Railway and Ship Terminals for Seattle, Wash.

City Wants Unified Railway Terminals—Propose Tunnel and New Line to Remove Rail Traffic from Waterfront

IN THE municipal problem of improving the waterfront, the industrial district and the complicated railway terminals at Seattle, Wash., a special feature is that the city authorities are endeavoring to secure unification of the entire terminal system, with operation either by the several railroads under a joint arrangement or by a single terminal organization for the terminal system as a unit. Since the railroads do not regard this proposition with favor, the solution of the improvement problem is making slow progress, but it is being pressed by the city in conjunction with city-planning and city-zoning developments. In these developments the problem is: (1) To provide adequate rail service and street access to the industrial area, and (2) at certain points to provide clear highways for through vehicle traffic and street railway lines.

Of four trunk railroads serving Seattle, the Oregon-Washington (Union Pacific System), the Chicago, Milwaukee & St. Paul and the main line of the Northern Pacific enter from the south, while the Great Northern and the Canadian branch of the Northern Pacific enter from the north (Fig. 1). In addition, there is a local line, the Pacific Coast R.R., which also enters from the south. The railways approaching from the south run at the foot of the hill on the east side of the valley as far as Argo, beyond which they spread out over the entire valley to the northward. Each of the four trunk railways has its own yards, freighthouses, warehouses, elevators, industrial spurs and waterfront connections. It is considered that with joint usage or unit operation these various facilities could be operated more systematically and with a reduction in the amount of traffic which, owing to topographical conditions, has to be handled along a busy waterfront. Two main passenger stations, side by side, serve two trunk lines each.

Seattle occupies a strip of land lying between Puget Sound and Lake Washington, as shown in Fig. 1. This land rises abruptly from its western shore and is furrowed by a series of ridges and valleys running parallel with the coast, so that railway access is restricted to the north and south ends. The city became prominent in Pacific Coast developments in 1883-1889, when the Northern Pacific R.R. was building its line to the coast and other lines were seeking strategic positions for terminals. The Northern Pacific at first proposed making Tacoma its terminal. To offset this, Seattle stimulated the construction of the Seattle, Lake Shore & Eastern Ry. to the east and north; this line is now the Canadian branch of the Northern Pacific. The Great Northern next entered the city and then the Northern Pacific also extended its line into Seattle. As a result of the competition of the various companies, so much land was acquired that it is claimed the area of railway property is excessive, even allowing for the city's future growth, and that the holding of this property has handicapped industrial development.

About 1903 or 1904, studies were begun under the then city engineer, R. H. Thomson, for the establishment of both street and railway grades on the tideflats, or filled land along the shore of Puget Sound. In 1915, A. H. Dimock, who had succeeded Mr. Thomson as city engineer, was instructed to plan a relocation of the track system that would meet the requirements of the railway business and cause less interference with industrial development. No official action has been taken, however, upon the several alternative projects submitted. In 1918, the State Public Service Commission (now a branch of the State Board of Public Works) engaged Mr. Thomson, the former city engineer, to report on the co-ordination and unification of the freight terminals of the railways reaching Puget Sound. This report, made in 1919, afforded an excellent basis for later detailed studies. In 1920, the city authorities appointed a zoning commission, which has planned the zones shown in Fig. 1. The residence areas are on high ground, approached from the business and industrial areas by grades of 8 to 24 per cent.

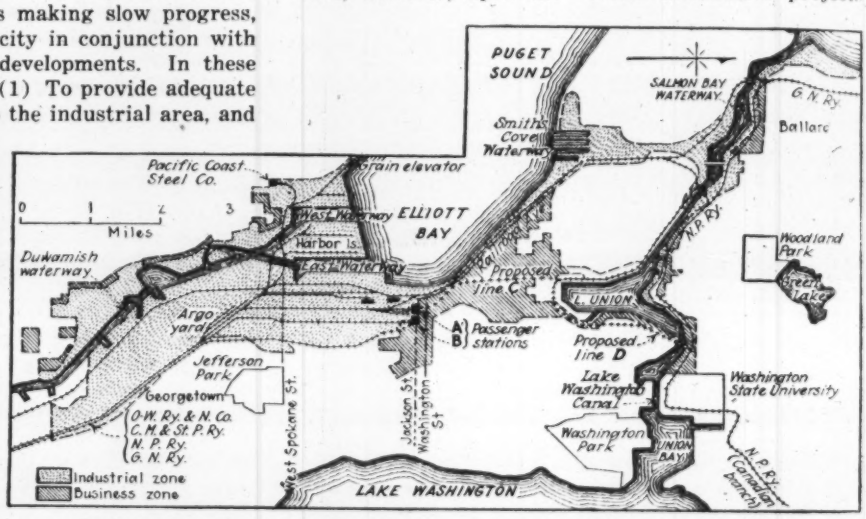


FIG. 1—RAILWAY TERMINALS AND CITY ZONING DISTRICTS, SEATTLE, WASH. Passenger stations: *A*, Great Northern Ry. and Northern Pacific Ry.; *B*, Oregon-Washington Ry. and Chicago, Milwaukee & St. Paul Ry. Through traffic and switching now concentrated on Railroad Ave. may be relieved by new line *C-D*.

At the north end of the city is the Salmon Bay Waterway (with lock connection to Lake Washington), on which are located some of the Seattle Port Commission's terminals. Here, also, is Smith's Cove, with the largest terminal of the Port Commission, alongside of which are the elevators and wharves of the Great Northern Ry. On the south are the East and West Waterways, which are designed to be the trans-oceanic shipping points served by the railroads entering from the south. Between Smith's Cove and the Waterways is a narrow strip of land along which extends Railroad Ave., a wide street which not only serves the waterfront and provides a through connection, but also has six or seven railroad tracks, since it forms the main route connecting the south and north railroad facilities.

To improve these conditions by eliminating main line railway traffic from Railroad Ave. and also to provide adequate railroad and steamship terminals the plan shown in Fig. 2 was prepared, and it is believed by J. D. Blackwell, city engineer, that this general scheme will be followed in the solution of the terminal problems.

Grade Separation—Some of the railway franchises provide for eliminating specific grade crossings at the expense of the railways. The city council has ordered complete studies of these crossings, but the city's engineers consider that such sporadic eliminations would not conform with a general scheme of improvement. One of the busiest thoroughfares is West Spokane St., which crosses all the railways at grade. It is considered probable that a main highway will be constructed near the foot of the hill, east of the railroad tracks, for the through traffic south of this street (Fig. 2).

There is urgent need for the separation of grades at several points, but until a comprehensive scheme has been adopted both the railroads and the city are disinclined to proceed. Any such scheme will entail a very large expenditure, of which probably the city will have a substantial share in consideration of the approaches and readjustments. Several tentative plans have been considered and assistance will be rendered by the new city-planning commission. Further studies are being made under the direction of J. D. Blackwell, city engineer, and E. L. Gaines, engineer and secretary of the city-zoning commission.

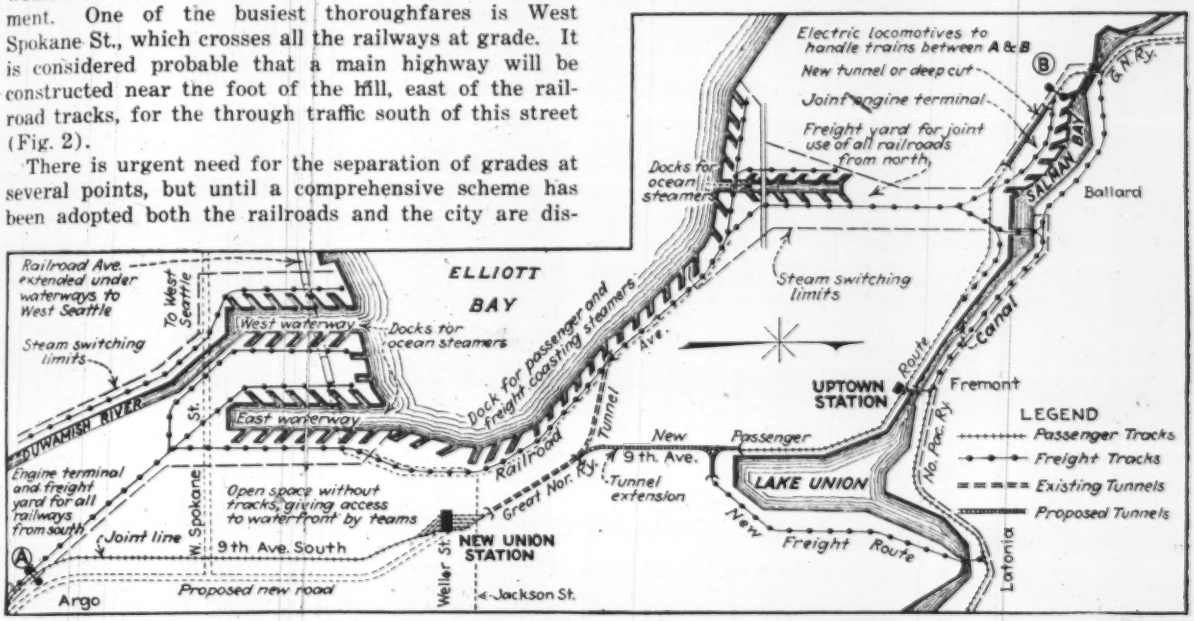


FIG. 2—PROPOSED RAILWAY AND MARINE TERMINALS, SEATTLE, WASH.
All passenger and through freight handled over new route by Lake Union, leaving Railroad Ave. clear of all but switching and transfer service for the docks.

Unit Operation of Terminals—Since the Argo yard constitutes an obstacle to street traffic and street development, Mr. Thomson proposed to establish a large new yard for the joint use of all lines, adjacent to the Duwamish Waterway, south of West Spokane St. But the railways oppose any such merging of terminal facilities. It is of particular interest to note, however, that unit operation was introduced successfully during the World War, the entire terminal system being then under the direction of one terminal superintendent. At that time there were seven main freight yards, as follows: Northern Pacific Ry., Spokane St. yard, Interbay yard and Middle yard; C., M. & St. P. Ry.; Van Asselt yard and Stacey St. yard; Great Northern Ry., Interbay yard; Oregon-Washington Ry., Argo yard. In addition there were several local yards and team yards and freighthouses.

For operation, the unit terminal was subdivided into three districts: (1) Southern district; the Argo yard was used as a receiving yard for trains from the south and east on the Northern Pacific, Oregon-Washington and St. Paul lines; the Van Asselt yard was used as a storage yard, mainly for export business. (2) Central district; this included the Stacey St., Spokane St. and Middle yards; the Stacey St. yard was used for classification and local distribution to docks and industries; also for assembling outbound trains to the south and east over the Northern Pacific, Oregon-Washington and St. Paul lines. (3) Northern district: this comprised the two Interbay yards, which were operated as a unit for all inbound and outbound business of the Great Northern Ry. There was no consolidation of freighthouses, owing to heavy business, but four car repair yards were reduced to three. The two passenger stations were operated as a unit under one station superintendent. Furthermore, much terminal mileage was saved by placing cars arriving from different roads in the yards from which distribution could be made most conveniently and expeditiously. Shippers and consignees benefited by the greater expedition in delivering and forwarding freight and by the fact that there was only one organization to deal with in regard to all railroad business, complaints and information.

One advantageous result was reported to be in reducing the switching movements, as many of the docks and industries were served by two or more railroads, each of which previously had done its own switching. There was an advantage also in pooling the switch engines and assigning them to work according to their size and power. By using the yards for special purposes without regard to ownership, business was facilitated, car movements were reduced and delays avoided.

New Through Route—In the present railway arrangement, the Oregon-Washington passenger station is a stub-terminal fronting on Jackson St., but the adjacent union station has tracks which continue across Jackson St. and enter the Great Northern's double-track tunnel

which opens into Railroad Ave., as described. A plan proposed by the Municipal Commission (*Engineering News*, Aug. 8, 1912, p. 256) provided for a new main line starting on the south at Georgetown, keeping parallel with and east of the Oregon-Washington Ry. and continuing beyond Jackson St. by tunnel to the southwest corner of Lake Union, where a union station was to be built. Thence the line was to follow along the lake and Salmon Bay Waterway to connect with the existing line extending to the north. For freight service, the existing Great Northern tunnel would give connection with the waterfront facilities.

The plan as now tentatively suggested by Mr. Blackwell and shown in Fig. 2 is somewhat similar, but the line would start near Argo and have a union station near the site of the present two stations, which is more convenient to the business district than a station at Lake Union. This station would have two sets of stub tracks end to end for trains making this a terminal point, while through tracks would be provided for through trains. W. Spokane St. would be double-decked, the lower level being for local traffic and the upper level for street-cars and West Seattle business, crossing the Duwamish Waterway by the single-deck bascule bridge which was completed in December, 1924. This bridge has 40-ft. headroom to provide for small vessels. Railroad Ave. would be extended by tunnel under the East and West Waterways. Ocean steamers would be berthed at the north and south ends of the city, the intermediate waterfront being assigned to coastwise and local traffic.

All railroad passenger and through traffic would be handled over the new line, only freight switching and transfer movements being handled on the waterfront tracks. Two main freight yards for universal use would be provided; one adjacent to Smith's Cove for all railways from the north, and one along the Duwamish River for all railroads from the south. This plan provides also for electric operation of all passenger and through trains between Argo and Salmon Bay, and for switching by electric locomotives along Railroad Ave.

N. J. Sewage-Works Operators' Licenses

Eighty-eight men have passed the required examinations as a condition of appointment as sewage-works operator in New Jersey since the state law requiring such examinations was passed in 1918. No examination was held until June 21, 1921, but prior to that 158 licenses were issued to operators serving 153 cities before the act became effective. Some of the examinations have been for promotion, there being four classes of operators, grading according to responsibilities to be assumed, ranging from superintendents competent to operate and test the efficiency of a work affording "complete" treatment down to an operator shown to be able to operate a settling or sedimentation plant only without making tests. Of the 246 persons granted licenses because already in office or after taking examinations only 7 have been discharged from their positions in five years—three for political and four for unknown reasons—whereas before the act became effective there were 25 to 40 per cent of dismissals after each election. An amendment to the licensing act prohibiting discharge for political reasons was proposed for consideration at the recent meeting of the New Jersey Sewage Works Association, the proposer being H. P. Croft, chief engineer of the New Jersey Department of Health.

Good and Bad Water Supplies in Indiana

ANALYSES of public water supplies in Indiana made during the year ending Oct. 1, 1924, showed that for treated river and lake supplies from driven wells 93 per cent of all the samples analyzed were "good" and but 7 per cent "bad" according to the laboratory standards of the American Water Works Association.

TABLE I—RELATIVE NUMBER OF GOOD AND BAD SAMPLES FROM INDIANA PUBLIC WATER AND ICE SUPPLIES AND BOTTLED WATERS

Source	Number of Samples		Percentage	
	Good	Bad	Good	Bad
Rivers or streams (treated)	749	58	93	7
Rivers or streams (no treatment)	1	23	4	96
Lakes (treated)	221	17	93	7
Lakes (no treatment)	6	1	86	14
Driven wells	469	33	93	7
Dug wells	55	6	90	10
Springs (treated)	111	12	90	10
Springs (no treatment)	32	32	50	50
Bottled waters (sold in Indiana)	71	2	97	3
Soda waters (carbonated and non-carbonated)	533	38	93	7
Artificial ice (sold in state)	275	17	94	6
Natural ice (sold in state)	35	11	76	24

The same percentage was found for commercial soda waters sold within the state. The number of samples examined and the entire range of figures for public water-supplies from other sources than those named and for artificial and natural ice are shown in the accompanying tables. The second table shows somewhat similar results of tests of water supplies of camps, rural schools and individually owned water supplies, only here the figures relate to number of supplies examined instead of number of samples. All the figures given are taken from a paper by L. A. Geupel, director, water and sewage department, Indiana State Board of Health, read late in 1924 before Central States Section,

TABLE II—COMPARISON OF GOOD AND BAD INDIANA WATER SUPPLIES FOR TOURIST CAMPS, RURAL SCHOOLS AND INDIVIDUALS

Tourist Camps Sources	Number		Per Cent	
	Good	Bad	Good	Bad
Deep driven wells	69	12	85	15
Shallow driven wells	13	17	43	57
Dug wells	4	11	27	73
Springs	10	7	60	40
Satisfactory city supplies	38	0	100	0
No water supply	0	7	0	100
Total	134	54	71	29
Rural Schools				
Dug wells less than 25 ft.	0	7	0	100
Dug wells over 25 ft.	7	10	41	59
Driven wells, 15 to 25 ft.	4	0	100	0
Driven wells 25 to 100 ft.	101	18	85	15
Driven wells over 100 ft.	13	2	87	13
Total	125	37	77	23
Individually Owned Supplies				
Dug wells all depths	136	490	22	78
Driven wells less than 15 ft.	16	9	64	36
Driven wells 15 to 25 ft.	86	55	61	39
Driven wells 25 to 100 ft.	440	131	77	23
Driven wells over 100 ft.	131	34	79	21
Cisterns	20	31	39	61
Springs	45	51	47	53
Total	774	801	49	51

American Water Works Association, at Wheeling, W.Va. Mr. Geupel has since resigned from this position.

The waters of the southern end of Lake Michigan, southeast of Chicago, Mr. Geupel states, "are dangerously affected by the very concentrated pollution" they receive. He adds: "Aeration, sedimentation, filtration and chlorination are essential for those supplies taking water from the concentrated polluted area and even with the above treatment the water is not palatable, due to industrial pollution yielding obnoxious tastes and odors."

Reinforcing a Cast-Iron Bridge in France

Steel Tension Rods Laid Along Arch Ribs and Cased in Concrete Slab on Intrados—New Bracing and Concrete Deck

STRENGTHENING an old cast-iron arch bridge with steel and reinforced concrete was accomplished in France in 1923 by the Paris, Lyons & Mediterranean Ry. This double-track bridge across the Rhone at La Voulte, built in 1861, has five spans of 182.3 ft., each with four cast-iron ribs built up of segmental sections and carrying open spandrels of cast iron. Numerous cracks had developed, and, as in consequence only the lighter engines were allowed to cross, the bridge interfered with traffic operation. A project for replacement of the arches with steel truss spans had been approved just before the war, but when the war was over the price of metal had increased so enormously that this plan had to be abandoned. A method of strengthening the old bridge was then devised and met with the approval of the authorities. A typical span is shown in Fig. 1, with details in Fig. 2.

Steel rectangular frames or sway braces were first placed between the ribs at the radial joints to replace the original cast-iron frames, which were badly cracked. After each frame was in place, the corresponding cast-iron frame was removed; this work was made difficult by the rusting of the attachments in the pockets formed on the rib members.

The next step was to place a 1½-in. steel rod along each edge of the bottom flange of each arch rib (see

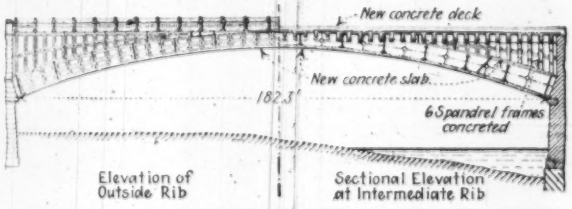


FIG. 1—CAST-IRON ARCH BRIDGE REINFORCED WITH CONCRETE AND STEEL

Fig. 2); these rods were held in place by being tied to transverse reinforcing rods spaced 8 in. apart and having their ends looped around the flanges (passing through holes in the webs). The longitudinal arched rods were placed in sections and were connected by turnbuckles. Their ends were welded to short stub rods with threaded sockets on screws passing through steel saddles bolted to the end shoes or castings of the ribs. By means of sleeve nuts on the screws and stubs, the proper tension was put in the rods. When this work was completed, two layers of lighter reinforcing rods were placed and the entire system of rods was encased in a 4-in. slab of concrete extending across the full width of the arch and increased in thickness at each rib to embrace the bottom flange and the attachments of the longitudinal tension rods. A similar slab embraces the top flanges of the ribs for about 21 ft. from each pier.

A 6½-in. reinforced-concrete deck slab was then laid on the spandrels and crown of the arch, embracing the top flanges and being strengthened by transverse beams or joists 20 in. deep, spaced to conform to the vertical spandrel frames. For lateral rigidity at the ends, the first six spandrel frames from each pier are embedded in transverse vertical slabs or partitions of reinforced concrete, connecting the deck slab with the short slab

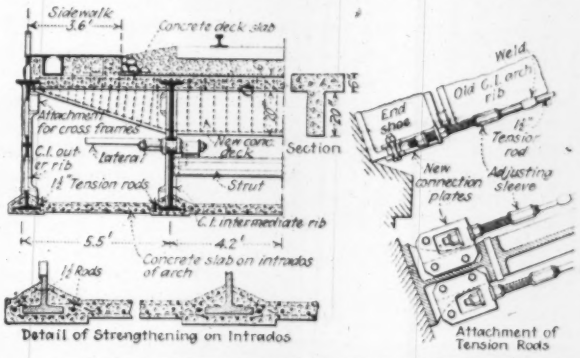


FIG. 2—DETAILS OF ARCH REINFORCEMENT

on top of the arch ribs. To insure a good bond, all metal surfaces were cleaned by sandblast before the concrete was placed. In addition, all cracks in the cast-iron parts were closed by electric welding.

With trains hauled by three heavy locomotives crossing the bridge at 35 m.p.h. there is now very little vibration. According to a paper in the *Revue Générale des Chemins de Fer* by M. de Boulongne, chief engineer of bridges of the Paris, Lyons & Mediterranean Ry., the cost of this strengthening was about $400,000, while reconstruction would have cost nearly $1,000,000.

City of Santa Cruz Extends Water System

THE city of Santa Cruz, Calif., with a population of about 14,000, has just completed a 37-m.g.d. concrete-lined reservoir located on Bay St. and a six-mile pipe line of 14-in. riveted steel pipe bringing in water from Major's Creek. This addition follows the hasty installation during the low-water period last fall of pressure filters and a chlorination plant in the bed of the San Lorenzo River which runs through the city. The old supply comes from springs and small streams from which a 10- and 14-in. riveted steel pipe brings the water by gravity some 10 miles to storage and distribution reservoirs located on hills within the city limits. With the new source of supply and the filter plant as a standby the system is expected to be adequate for some years to come.

The new reservoir, built under contract at a cost of $165,000, has rolled earth embankments lined on the inside with 6 in. of 1:2:4 concrete. Contraction joints were placed in the concrete every 30 ft. in each direction, with asphalt and oakum fillers. Concrete beams were put in under all contraction joints and a system of tile drains underlies the concrete work. The concrete has a hand-troweled surface.

The emergency pressure filters are located within the city limits at a point where an adequate supply of water is always available in the gravels of the stream bed. When used, water from this source is pumped directly into the distribution system. Pumps and Diesel engines, together with the filter control apparatus, are housed in a temporary structure, the filters being placed outside the building. These filters are expected to effect a clarification of about 70 per cent and are supplemented by chlorination.

Stereophoto Surveying from the Air

Topographic Surveys Carried Out by New Process Producing Contoured Maps Free From Distortion — Elevations Measured by Differential Displacements on Pairs of Plates

IN THE survey of a mountain valley in the southern Appalachians for power-development purposes, recently, a new process of airplane photographic surveying was applied, with excellent results, according to statements of the engineers for whom the survey was made. The new process, known as the Brock process, lays special claim to accuracy and range of application especially in topographic work. It produces maps which are not merely reproductions of pictorial representations of the country, but true-scale maps, with or without contours. In the specific survey just mentioned, the engineers verified the accuracy of the maps by a ground survey, and reported that "they checked with remarkable accuracy." The process has been under development for several years, and is now in perfected form for regular commercial use. Its technical application is in the hands of the engineering firm of Brock & Weymouth, Inc., of Philadelphia. The special instruments by which it is applied were developed by the Arthur Brock, Jr., Tool & Manufacturing Works, a firm specializing in precise and automatic production machinery and scientific instruments.

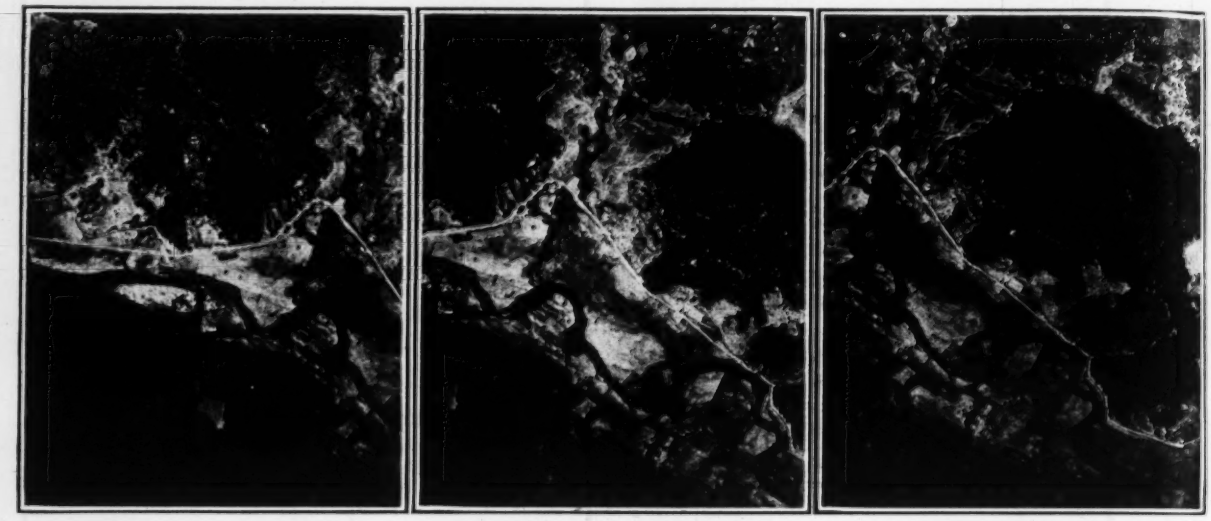


FIG. 1—THREE CONSECUTIVE AIRPLANE PHOTOGRAPHS MADE FOR A TOPOGRAPHIC SURVEY

Underlying the Brock process is a careful analysis of the differences between measurement and mapping on the one hand and pictorial representation on the other. This analysis made it possible to accomplish a complete transfer from the picture perspectives or conic projections of the original photographs to topographic representation embodying measured distances and elevations. The construction of special instruments gave the means for carrying out this transfer rapidly and with precision.

Stereophoto Basis—In its essential nature the Brock process is stereophotographic. In each step, two photographs taken from different positions of the airplane but having overlapping fields are used in conjunction, to determine the position and elevation of points in the area being surveyed; thus, in Fig. 1, the plates *A* and *B* are used in conjunction, and similarly *B* and *C*. Stereoscopic vision is not used as a means of measurement but only as an auxiliary, though an essential auxiliary. The actual survey data are furnished by accurate measurement of relative displacements of corresponding points on the two plates of the pair.

Certain information requires to be obtained on the ground, in order to give scale, and to permit of adjusting and co-ordinating the plates. This information comprises (1) a known base line at beginning and end of the survey network (or at intervals of 15 to 20 miles in a long network), and (2) the differences of elevation of four points in the field of each pair of plates. All other data are derived from the photographs. It is not necessary that the actual elevations of the four points on each plate be known, but rather their differences of elevation.

Elements of Process—The process makes use of photographs taken in approximately horizontal position (camera axis approximately vertical). Its characteristic feature is (1) a determination of the error in horizontality, or the tilt, *from the plates themselves* by differences of displacement (or parallax) of the control points, followed by (2) correction of the plates to true horizontality by the ingenious device of rephotographing them at the angle of tilt. This part of the process is based on recognition of the fact that the absolute angular position of the camera on the airplane at the moment of taking a picture cannot be determined by level readings or the like—since a bubble is affected by accelerations just as is the suspended camera—and that also it is not feasible to maintain verticality of camera even by gyroscopic devices. On the other hand, the data from which the tilt of plates can be determined are contained in the pictures themselves and comparative measurements on a pair of plates based on a few datum

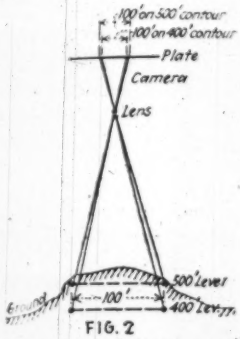


FIG. 2

FIG. 2 — DIFFERENCE IN SCALE OF DIFFERENT CONTOURS

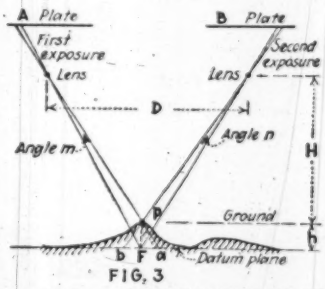


FIG. 3

FIG. 3—PARALLAX DUE TO ELEVATION OF GROUND POINT

points give a means of determining the tilt of each plate. After correction of the original plates to horizontality, measurements of the same kind as those first used in determining tilt are then applied to determining the elevation of all the points of the survey area. This step is most conveniently carried out by locating consecutive points of one contour line, then of another contour, and so on. Finally, the contoured plate, which is a conic projection and therefore not uniform in scale, is transformed by an ingenious replotting method to a true-scale orthographic projection, or map.

Horizontal-Plate Principles—Since a photograph is a conic projection, it will be apparent that when a plane horizontal ground area is photographed on a horizontal plate by an aerial camera with vertical axis the photograph is a correct map, but that when an uneven ground area is similarly photographed the higher portions will appear on the picture to a larger scale than the lower ones. (Fig. 2.) On such a plate any contour line will be shown in geometrically correct form, but different contours will be shown to different scales; that is, a horizontal distance of 100 ft. on the 500-ft. contour will be a longer line on the photograph than a 100-ft. distance on the 400-ft. contour. The amount of the difference depends on the height of the airplane. A contoured photograph of uneven ground is therefore a distorted representation, and in order to be converted to a true map it must have each contour replotted to corrected scale. This operation is made relatively rapid and easy by special methods and mechanical devices, which convert the various contours in turn to the desired uniform scale of the final tracing.

The same scale-changing effect of elevation of ground also results in distorting the boundary of the area represented on a plate, so that the rectangular plate does not correspond to a rectangular map section, and indeed the straight edges of the plate do not correspond to straight lines on a map. This obvious effect is the reason why adjoining photographs of ground with relief, even though taken on horizontal plates, can not be fitted together.

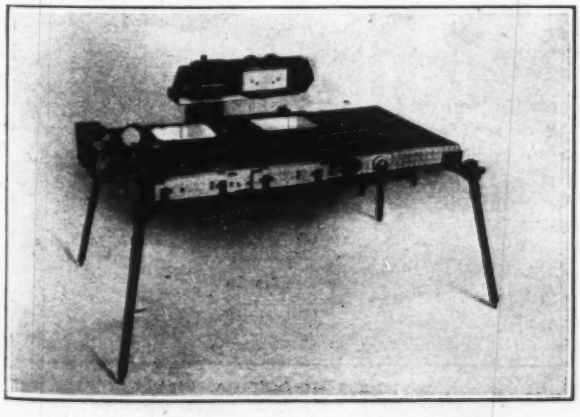


FIG. 4—BROCK STEREOSCOPE TABLE

Measuring Elevations—If two horizontal plates *A* and *B*, Fig. 3, in two cameras at a lens height *H* above ground show in their field a point *P* situated at height *h* above the datum plane of the territory, the two images of point *P* will be displaced from the positions which they would occupy if the point were in the datum plane (at *F*) by distances corresponding to the small angles *m* and *n*. The amount of displacement on the plates corresponds to the ground distance *ba*, and is divided between the two plates in accordance with the horizontal distances from *P* to the two lens positions. A variety of these distances and of ground elevations bring about a variety of displacements of the various image points on the plates. Since the ground distance *ba* is a direct function of the exposure interval *D*, the lens height *H*, and the elevation *h*, it is evident that in a given pair of photographs (*D* and *H* being constant) the displacement depends only on the height *h*. Thus, differences of elevation between two ground points in the pair of photographs are represented by a relative shift of the one point with respect to the other, as the observer proceeds from the first plate to the second. By measuring these shifts on the plate, therefore, differences of elevation of the ground points are directly measured. Such measurement is done on a stereoscope measuring table (Fig. 4), a device of fundamentally simple construction but necessarily of high precision.

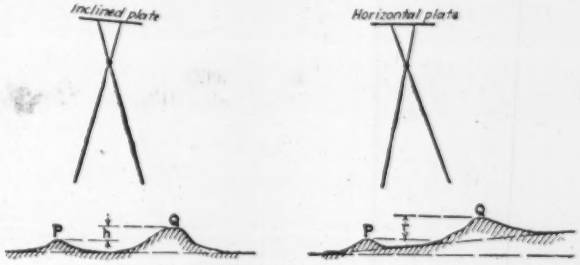


FIG. 5—EFFECT OF TILT OF PLATE

Picture of horizontal ground area on inclined plate, sketch I, is identical with picture of sloping ground area on a horizontal plate, sketch II. Unless tilt of plate is determined and corrected, elevation *h* is erroneously determined as *r*.

Determining Tilt of Plate—For reasons already indicated, it is not in general possible to make airplane pictures with camera axis vertical (plate horizontal). Careful construction, and delicate anti-friction gimbal suspension of the camera, succeed in keeping the camera very close to vertical, but nevertheless slight movements occur, which have the effect that each exposure may be at a different (and unknown) tilt from the horizontal. This tilt is of very small amount—not more than a few degrees in extreme cases—but it is sufficient to distort the relation between ground surface and picture. In order to obtain usable survey data from the air pictures, then, it is necessary to determine the tilt with great accuracy, and make correction for it.

Reference to the sketch Fig. 5 will make it obvious that the picture of a horizontal area on a tilted plate

is similar to a horizontal-plate picture of a sloping area. Bearing in mind what has previously been said of measurement of differences in elevation, it may be seen that an attempt to determine difference in elevation between two points *P* and *Q*, in sketch II of Fig. 5, would give a false difference, *r*, having no relation to the actual difference *h* in sketch I. Correct results can thus be obtained only if it is possible to adjust the tilted plate to the horizontal.

It is entirely possible, however, to use a pair of consecutive plates as the two elements of a stereoscopic *picture* even though they are not precisely horizontal or parallel, but have different tilts. Further, consider-

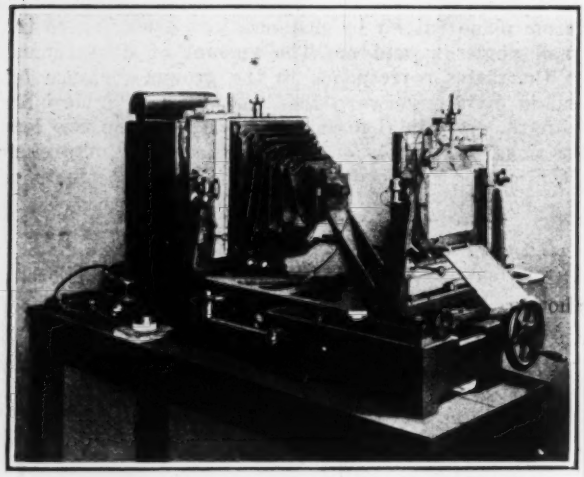


FIG. 6—REPROJECTION APPARATUS

ing a pair of non-horizontal plates in their relation to the surface of the ground beneath, it may be judged that what was previously stated as to measurement of elevations (Fig. 3) still applies, except that the displacements of the image points on the plates are falsified or distorted. If, however, the differences of elevation between several points on a plate are known, the elevations as measured by the methods previously indicated may be compared with the actual differences of elevation, and the amounts of tilt of the two plates determined from this comparison.

In applying this method, the elevation shifts are measured for points on one edge of the area of a plate; these points are also found near the middle line of the other plate of the pair, where the elevation effect is zero or very small. A relatively simple calculation permits of computing from these shifts, as compared with the actual differences of elevation, the tilt of plate around an axis parallel to the edge in question. The same process carried out along another edge of the plate indicates the tilt in the other direction. By this process, comparison of the original pair of plates on the basis of known differences of elevation for a number of points located around the edges of the plates results in determining numerically the tilt of the plates, and thus gives the necessary information for correcting the plates to horizontal. The measurements for the determination of tilt of plates are made on the stereoscope table (Fig. 4). From these data, the plates are rephotographed in such a way as to produce a horizontal plate.

The tilt determination and correction is made for each pair of plates independently. The correction for a plate when used as the second plate of a pair is not retained for the following pair where it is the first plate, but a new adjustment or correction is made of this pair. This practice avoids the accumulation of small residual errors.

Drawing Contours—The corrected photograph and the similarly corrected other plate of the pair are placed on the stereoscope table for measurement of all desired elevations and drawing of contours. Differences of elevation are measured in terms of parallax (plate image of distance *ba*, Fig. 3), which is directly convertible into elevation difference. Contours are drawn by marking on the plate successive points of the ground which have the same parallax. This process is greatly facilitated by the stereoscopic effect in rendering vertical distances perceptible. With a given setting of the stereoscope, when the appropriate contour is brought into the center of the field the crosshairs appear to lie on the ground surface, and it is easy to carry them along the ground in the direction of the contours. This effect is not depended upon other than as a guide and aid, however; the actual determination of a contour point is made by the parallax for the elevation of the coutour.

Plotting the Map—With the plates corrected and contoured, scale correction by replotting remains to be carried out, in order to produce a map. The basic network for this plotting is obtained by laying down the position of the various controlled points on each plate. Since these plates have been corrected to the horizontal, the positions of such points are correctly shown on the plates except for the effect of scale difference or parallax due to elevation. The plates being taken so as to overlap slightly more than one-half, points at one edge of one plate will appear in the middle of the next plate and at the farther edge of the following plate, and it is therefore possible to orient successive plates with great precision by these results.

Results Obtained—Contour mapping by the Brock process is claimed to have the advantage of superior accuracy, speed, economy and completeness of detail over ground surveying. According to an engineering study recently carried out, the contour location could be relied upon within limits of 2½ ft. plus or minus. Certain instrumental improvements since completed, Brock

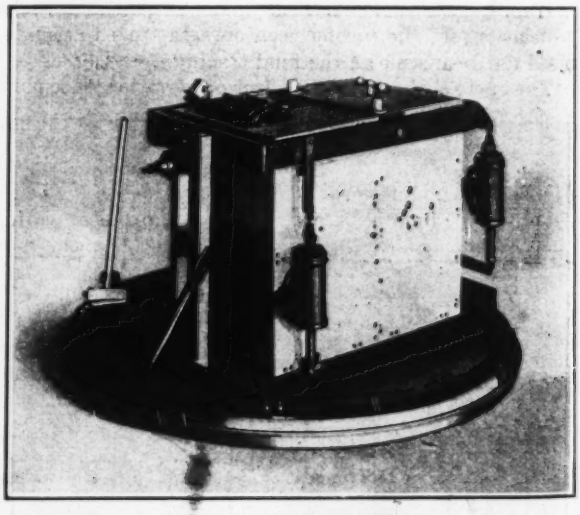


FIG. 7—BROCK CAMERA
Camera suspended in antifriction gimbal mounting; motion damped by dashpots.

FIG. 8—A CONTOURED PLATE

& Weymouth state, reduce the mechanical limitation to less than a half foot, so that in practice contours can be located with confidence of their accuracy within limits of one foot plus or minus.

Fig. 9 is a piece of a map made by the Brock process in the basin of Green River, North Carolina, for the Blue Ridge Power Co. The country is of bold relief and heavy forest cover, which would have greatly delayed ground surveys, but offered no obstacle in this process. With stereoscopic vision it was a simple matter to see between the trees and contour the ground. The flying was done late in 1923 and about 55 square miles were photographed. In all, about 40 square miles were represented on the finished contour map. Contour intervals of 25 and 50 ft. were shown, to different elevations, as needed.

In another job in an eastern state an interesting check on the ground work was obtained. The control measurements were supplied by the engineers of the company purchasing the map. Reduction of the photographs indicated clearly an error in a linear ground measurement. The company was asked to check the distance measured and telegraphed a correction agreeing in amount with that already indicated by the stereoscopic work and plotting.

Details of Practice—In carrying out aerial surveys by the Brock process certain characteristic practices are followed. The most important is the exclusive use of plates. Films have been found incapable of giving satisfactory results in survey work, partly because of difficulty in getting the films to lie flat, but chiefly because of the tendency of the coating to loosen, shrink and creep in development. As the method of using the pictures for obtaining precise survey data depends upon accurate measurements of the position of points on the pictures, such displacement must be eliminated. Glass plates are free from creep or shrinkage defects. Care is taken to obtain specially selected plates, in order that the closest possible approximation to a true plane may be had.

Of the various instruments used, the camera is of most general interest. A standard 6½x8½ plate size is used in combination with short focus lenses; the largest focal length, 8¼ in., is preferred on large scale work with relatively low flying elevation. With this lens at 5,000 ft., an area of about ¾x1 mile is pictured on a single plate with approximate scale of 600 ft. to the inch.

Interchangeable magazines are used. The camera thus can be loaded in flight. It weighs complete about 70 lb., with magazines and 48 plates. It is hand-cranked, but otherwise automatic, and novel in that it is built to avoid use of plate holders. Its lightness and the daylight loading feature permit large numbers of plates to be exposed in a single flight. The camera is specially made to fix on each photograph the footprint of the lens axis. A between-lens shutter is used. Normally the exposure time is about 1/150 second; specially sensitized emulsions are used.

Location of Ground Check Points—As previously stated, proper orientation of each plate as to tilt, which is the basis of the entire working out of the survey from the plates, requires knowledge of the difference of elevations of salient ground points, four or more of

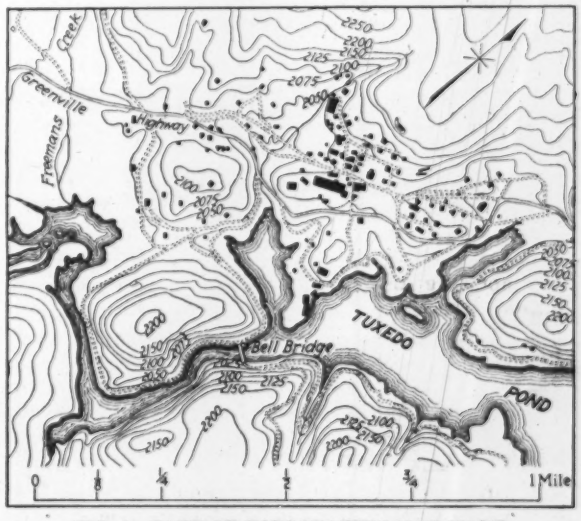


FIG. 9—PART OF TOPOGRAPHIC MAP MADE BY AERIAL SURVEY

which show on each plate, preferably near the corners. These points may be known from previous data or may be surveyed before or after the photographic work. It has been found usually cheapest to determine the elevations after the photographic work is completed, as the stereoscopic pictures permit of picking out points visible and identifiable from each of the successive picture positions, and it is then an easy matter to locate these points on the ground and determine their eleva-

tion. Hand stereoscopes are used in the field to aid in this location.

Development of Process—In its origin the Brock process is an evolution from military aerial reconnaissance work and the construction of instruments for this service. The evolution resulted from the aim to find means of producing precise results for technical mapping, by substituting mechanical operations for those involving human errors and extensive ground measurement. Machine after machine was constructed and tried in the course of ten years' development.

At an early stage it was found that, while the mechanical operations must be in strict accord with the mathematical principles involved, yet various limitations render impracticable certain methods that appear of high promise from a theoretical standpoint. Because of such limitations, efforts to avoid all ground control had to be abandoned. Protracted efforts to solve view angle and scale of picture from a single photograph proved unavailing. The principle of using overlapping views in pairs finally proved successful, and from it the Brock process in its present form was evolved.

Sign Painting with Silk Stencils, Ohio Road Department

Painting Outfits Described—Paint Formulas—Signs Stenciled for One Cent Each—Output 1,000 Signs a Week

By Harry B. Neal

Traffic Engineer, Ohio Highway Department, Columbus, Ohio

Upon adopting the standard highway warning signs recommended by the Mississippi Valley Association of State Highway Departments the problem of making the change as rapidly and as cheaply as possible became of importance. In view of the possibility of changes after a year or two of experience, it was decided to make all these signs of wood. The problem therefore was confined principally to the question of painting the signs, as the penitentiary has for several years been making boards at considerably less cost than they could be purchased. The boards are made of poplar with double tongue-and-groove glued joints.

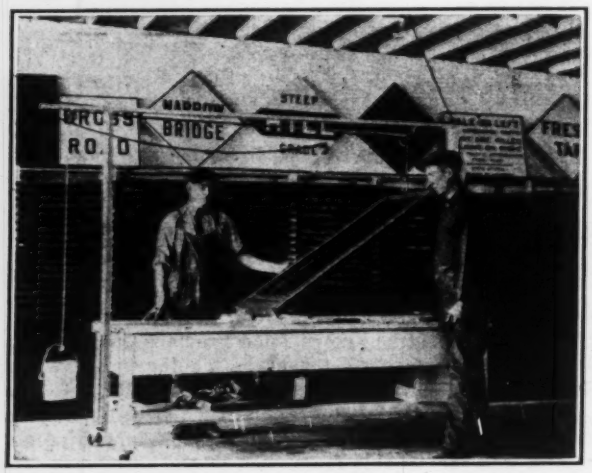


FIG. 1—STENCILING TABLE AND RACKS FOR SIGN BOARDS

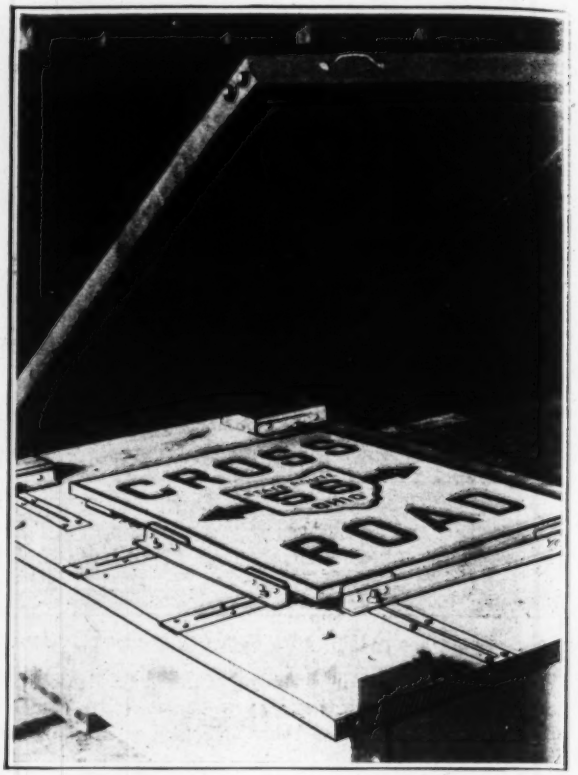


FIG. 2—CLAMPS HOLD BOARDS FIRMLY ON TABLE

At first the experiment was tried of having the signs painted in each of the eleven engineering divisions. Paper stencils were furnished by the central office. It was soon disclosed, however, that this method was decidedly unsatisfactory. In most cases inexperienced labor was employed and the workmanship was very poor and the rate of production was much too slow. Through lack of knowledge, of the proper drying time to be allowed between body coats as well as lack of adequate space for drying, the paint checked and peeled on many of the signs. It was then decided to establish a central sign painting shop. It was believed that this was the only way in which uniform quality of paint and workmanship could be obtained together with the required rate of production.

A small central sign shop was installed in the basement of the central office where preliminary experiments in production methods were conducted. It was determined that the only way in which the required rate of production could be secured was by the use of silk screen stencils. A stencil consists of a rigid wooden frame upon which is tightly stretched a diaphragm of silk bolting cloth. The design of the sign is painted upon the silk with a lacquer paint or filler, which is impervious to and is not affected by the oil paint used for stenciling. The lettering or design to be transferred to the sign is left open on the silk and the remainder is blocked out by the paint or filler. The silk bolting cloth may be obtained in a variety of grades. The grade found most suitable for our work is No. 8XX, with 86 meshes per lineal inch.

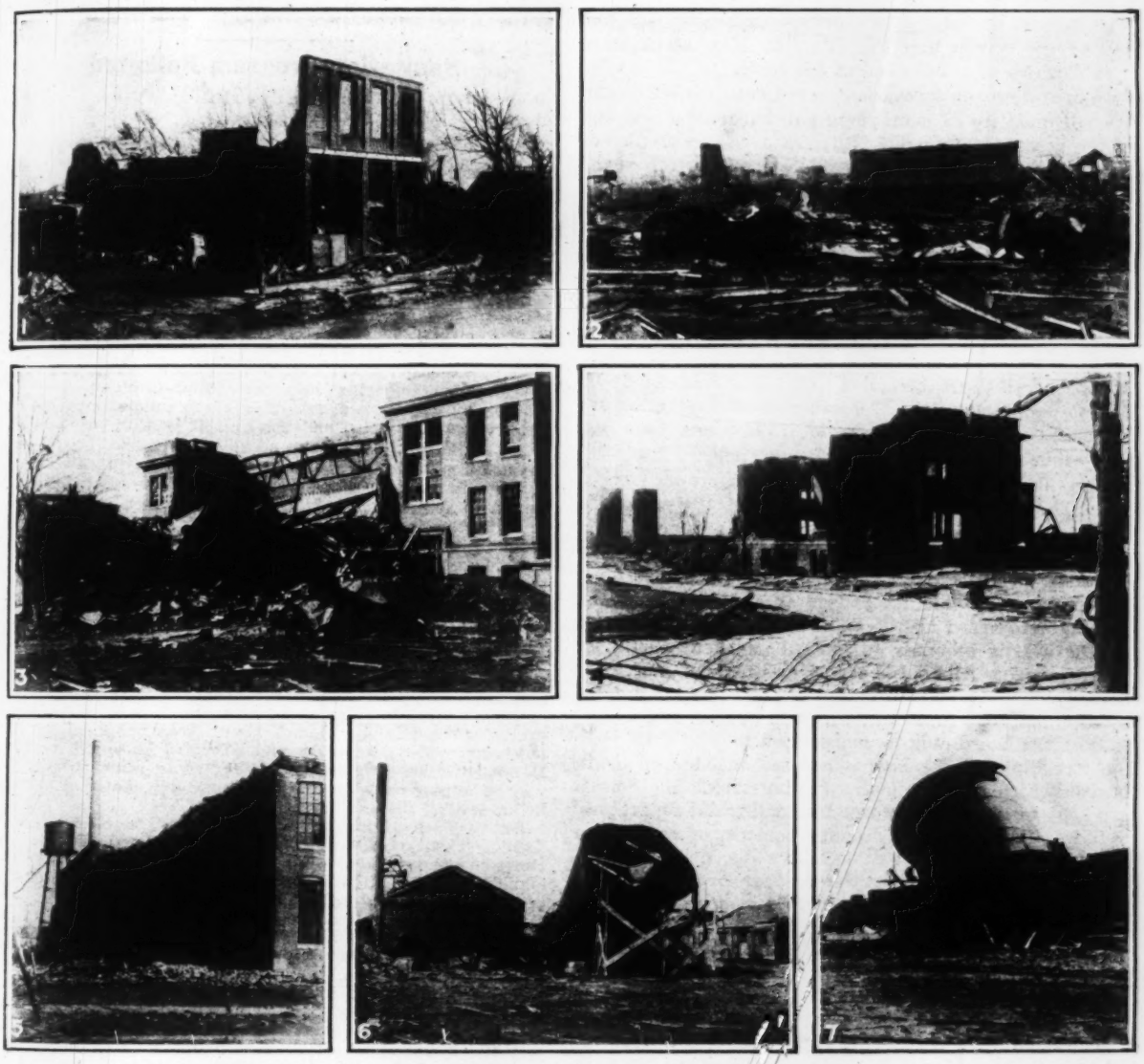
The frame is made of $1\frac{3}{4}$x$2\frac{3}{4}$-in. white pine. The corners are joined together by $\frac{3}{8}$x6-in. lag screws. Two lag screws are used in each corner. The frame has an adjustable cross member inside the frame at one end

which is supported by two ⅜x6-in. carriage bolts passed through the rigid member and the adjustable end member. These bolts are provided with wing nuts. The inside length of the frame is about 8 in. greater than the length of the sign to be made. Three sides of the frame and the adjustable cross piece have ½x⅞-in. grooves into which oak strips fit tightly. The silk is tacked to three sides of the frame and to the adjustable cross piece, being stretched as tightly as possible by hand. The oak strips are then forced into the grooves, still further tightening the silk which has been stretched over the grooves. The strips are held in place by screws. The silk is finally drawn as taut as possible by drawing up the adjustable cross piece.

The frame is placed face down over a drawing of the sign, which is then traced on the silk in pencil. The frame is then raised enough to clear the table and the design is cut-in with the filler. The filler dries rapidly and the screen is ready for use in 5 or 6 hours. The lacquer paint or filler may be purchased prepared for use or may be made if desired. There are a number of formulas for a paint of this character of which the following is typical and has been found to be very satisfactory: ¼ lb. English drop black dry; 1 qt. good orange

Some Items of Tornado Destruction in Southern Illinois

(Photographs by C. R. Dooling, Assistant Engineer, State Division of Highways, Carbondale, Ill.)



Views 1-5 from Murphysboro, 6 and 7 from West Frankfort

1—Store building with 8-in. unreinforced concrete wall. 2—Ruins of Mobile & Ohio R. R. shops. 3—High school building. 4—First Baptist Church, and steel wheat bins of Reliance Milling Co. 5—Top floor of Brown Shoe Co. factory, wrecked. 6—Undamaged reinforced concrete stack of New Orient mine, and wrecked water tank tower. 7—Tank tower, from opposite side.

shellac and 1 tablespoon castor oil. If this thickens in use it may be thinned as desired with a solution of 5 parts alcohol and 1 part castor oil.

In use, one end of the screen is hinged to a strip of wood the thickness of the sign to be stenciled. This strip is fastened to a 3½x7-ft. table which is about 30 in. high. The table has slots in which adjustable guides made of 1x1x¼-in. angle iron are set so that they may be moved independently of each other but which always remain at right angles to each other. A board of the size to be stenciled is placed on the table and adjusted under the screen until the design registers properly. The adjustable guides are then brought up against the edge of the boards and tightened in place. The table has an upright at each end supporting a longitudinal cross member. This cross member supports small pulleys through which a piece of clothes rope passes, one end of which is attached to the free end of the screen and the other to a counterbalance weight which clears the end of the table.

In operation the screen is lowered onto the board and a small quantity of semi-paste paint placed at one end of the screen. The paint is drawn over the surface of the screen by a rubber edge squeegee. This forces the paint through the open mesh of the silk, transferring the design to the board. The following is the formula for the black stencil paint used for No. 8XX silk cloth: 10 lb. lamp black in oil; 5 lb. whiting; 4 oz. turpentine and 1¼ pt. cobalt dryer.

The process of stenciling is very rapid and the labor cost is correspondingly low. Two men—one operating the screen and the other placing and removing boards—have several times stenciled eight hundred 24x24-in. boards per 8-hour day. At this rate of production the labor cost for stenciling is less than one cent per sign—much less than cost of paper stencils.

The silk screens will last indefinitely if properly cared for. The principal requirement is that the screen be thoroughly cleaned before it is put away after each run. This is easily done by wiping with a cloth soaked in kerosene.

Stenciling by this method is so rapid that it was necessary to speed up the application of the body coats on the boards in order to keep a sufficient supply of boards ahead. All boards are given three coats of paint before stenciling. The first and second coats are applied by dipping. The first coat, which is applied to the surface of the board only, is brushed on.

After dipping, the boards are set on edge on drain boards which drain into the dipping tank. The boards are kept separated while wet by small metal separators.

It was found that, by dipping, the cost of application of the first and second coats was reduced by approximately 75 per cent over the cost of brushing. The finish coat is brushed on in order to secure the smoothest finish coat possible.

After the final coat is applied the boards are placed in drying racks extending along two sides of the shop. The capacity of these racks is 1,000 boards. The screen table, mounted on casters, is moved along these racks.

The shop with a force of eight men has a capacity of 1,000 finished signs per week. The limiting factor in the rate of production is the time required for drying between each body coat. It would be possible of course, to stencil 600 to 800 boards per day if that many could be made ready for the screen. This, however, would require more floor space for additional racks.

The paint shop has approximately 4,800 sq.ft. of floor space, part of which is taken up by office space and storage rooms. No space is available for the storage of finished signs. Accordingly they are delivered to the eleven districts into which the state is divided, as fast as they are completed. Delivery is made by truck.

A practical painter of several years' experience is in direct charge of the shop. All paints used are mixed by him, no prepared paints being used. By this plan the quality of all paints used is insured.

It is estimated that 25,000 signs of various types will be required completely to mark the state system. In order to complete this work during the season of 1925 it was necessary to purchase a supply of lumber and make part of the supply of boards in the wood-working shop at the central garage. About 250 boards per day are required, part of which are supplied by the penitentiary and part by the central garage.

Sanitation Program Followed at Gary, Ind.

By W. P. Cottingham
City Engineer, Gary, Ind.

Abstract of a paper read at the recent meeting of the Lake Michigan Sanitation Congress.

GARY'S sanitation program may be said to have started nineteen years ago, when the engineers drove the first stakes for the steel mills and the town site. From its inception the city has been provided with sewers of sufficient capacity to care for its growth, as a plan for the sewerage system was developed and followed through the early years. A check has been made recently to ascertain wherein the plan needed revising.

In general, the sewer system consists of three north and south mains emptying into the Grand Calumet River at points about 2½ miles apart. The eastern main sewer serves the largest population and the area it is designed to serve is approximately 60 per cent occupied. We find it necessary to install a pumping station at a cost of $100,000 at the outlet this year to accelerate the flow; the station is designed to accommodate future pumps to feed a force main to carry the dry weather flow to a central treatment plant.

The need for a pumping plant is accentuated by the change of water level in the Grand Calumet River. When the Gary sewers were built the water level was about that of Lake Michigan, and with street grades at El. 20 we were able to have very satisfactory runoff in times of storm. The steel mills now pump several hundred million gallons of water per day through their operations into the river, and our sewer outlet is practically submerged. This immense pumpage, however, is a great boom to Gary and to the entire Calumet region, as it provides dilution water that prevents the Grand Calumet River from being so sewage laden as to be dangerous and offensive before it reaches Hammond. Tests indicate that for some years to come it will be unnecessary for Gary to make any material change in its sewage disposal system.

But we are preparing to do our part to clean up the Lake. Two years ago the firm of Alvord, Burdick & Hewson was engaged to study our situation and make recommendations of a general plan to cover the sanitary needs of the city. This firm had made the earlier plans for the U. S. Steel Corporation and for the town of Gary. A year ago it submitted the report and was instructed to prepare the plans for the pumping station to relieve the danger of flooded basements during storm periods. These plans have been presented and a bond issue is being arranged for constructing the station. Our consulting engineers are also working out a scheme of sewerage for the Little Calumet River marsh where great development will follow the completion of the Burns or Calumet drainage ditch (see *Engineering News-Record*, March 12, 1925, p. 432).

Our sanitation program has included protection to our water supply. The lake intake is in deep water about 1½ miles from shore, with a tunnel 90 ft. below water level. No filter beds have been found necessary and only a small dosage of chlorine is given.

Compact Underground Sewage-Works in Lower New York

Fine Screens, Chlorinators and Automatic Pumps of 40-M.G.D. Capacity Beneath Street Except Small Entrance Building

By William Goldsmith
Consulting Engineer, Riverdale Construction Co., Inc., New York City

TO INAUGURATE the opening of the 40-m.g.d. sewage screening and chlorinating plant at Canal and West Streets, New York City, a luncheon was given to the city officials on April 2. Construction of this plant is the largest single step yet taken to stop the pollution of New York Harbor. The plant is unique in that it is located at one side of the heart of downtown Manhattan; is entirely underground except for the 10x18-ft. one-story entrance building shown by one of the accompanying illustrations; is very compact, consisting merely of a 30x60-ft. pump chamber and a 70x70-ft. screening chamber, with bottom 35 ft. below the street level; and being entirely beneath the street no property had to be acquired for the plant.

To make the exterior of the entrance building attractive it is built of brick, trimmed with terra cotta, while to make the interior of the plant equally agreeable all its walls are covered with white-glazed tile, with blue-bordered panels and sanitary bases, the radiators and piping are bronzed and artificial ventilation is provided. In short, the plant is designed to show that sewage may be treated in the heart of the city, to as great a degree as the large volume of diluting water

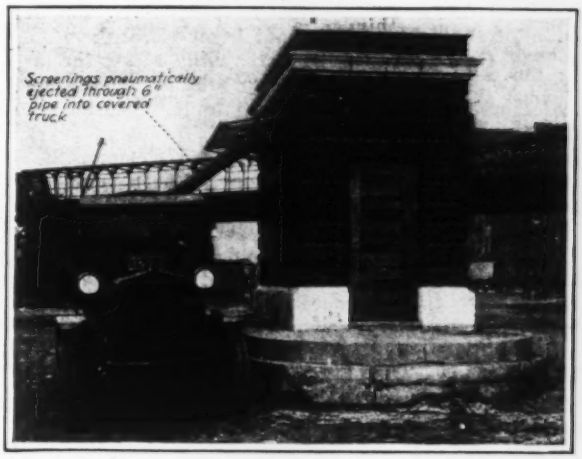


FIG. 1—EXTERIOR OF CANAL ST. SEWAGE SCREENING AND CHLORINATING PLANT, NEW YORK CITY

The only surface indication of this 40-m.g.d. plant is the entrance for employees and, when in use, the 6-in. pipe and covered motor truck for the ejection and removal of screenings. The bridge at the rear is a part of the construction plant of the vehicular tunnel to Jersey City.

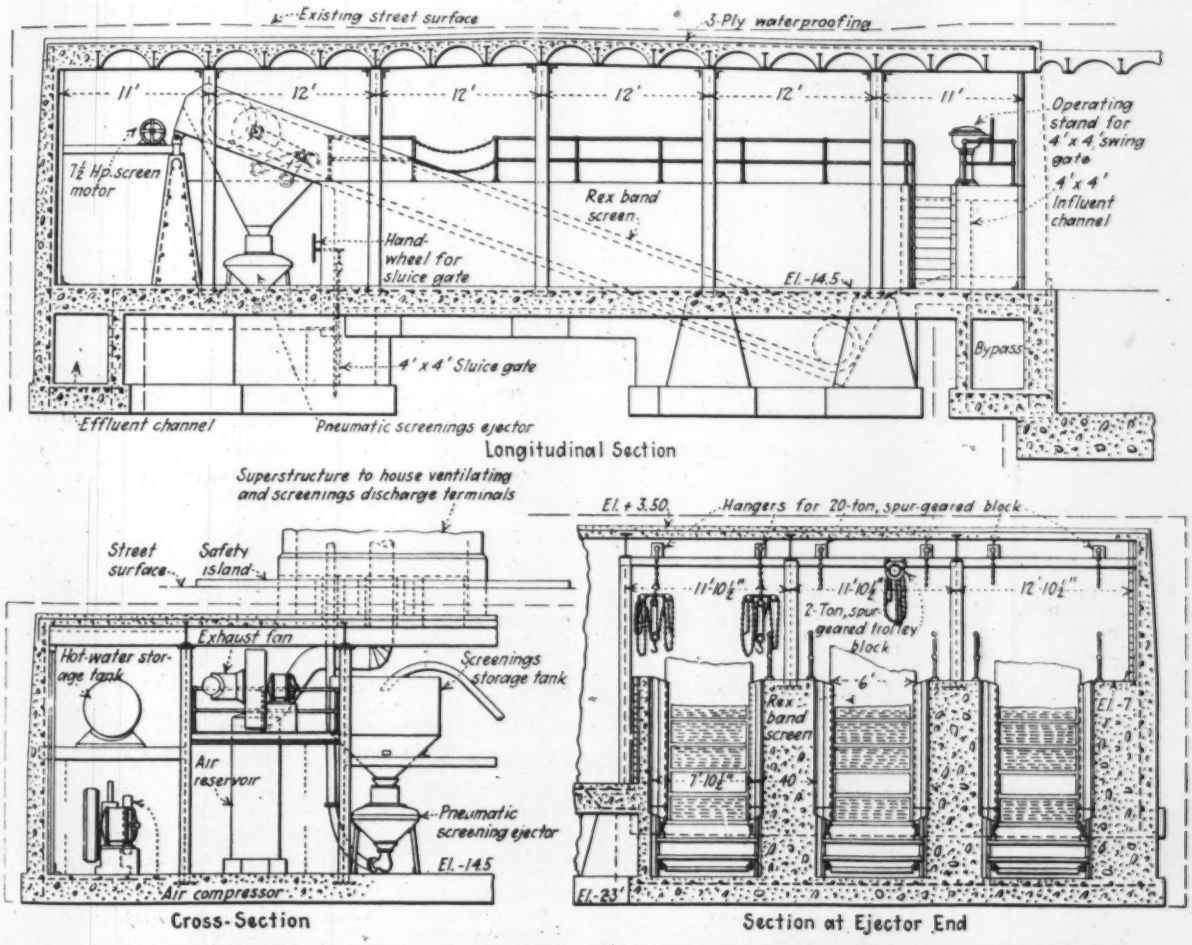


FIG. 2—SECTIONS THROUGH SEWAGE SCREENS AND SCREENINGS EJECTOR, CANAL ST., NEW YORK CITY

available necessitates, without producing obnoxious odors or requiring a plant that is an eyesore.

This Canal St. sewage-works will serve the area from Canal St. on the south to 14th St. on the north and from Broadway at the east to the Hudson River at the west. Manhattan has had for some years a fine-screening plant at the foot of Dyckman St. of another type of screen (Riensch-Wurl) and much smaller in size (7.5 m.g.d.). This serves the area from 173d St. north to the Harlem River and from Broadway to the Hudson. The Canal and Dyckman St. plants together make a good start toward treating the sewage tributary to the Hudson River. The operation of the former, in view of its compact and underground character, will be observed with interest, as bearing upon the feasibility of this type for congested sections.

At Canal St. three Rex band inclined traveling screens are being used, each 6 ft. wide by 65 ft. long, composed of finely perforated manganese bronze plates fastened on the endless chain which moves the screen. The perforations are $\frac{3}{64}$ in. wide by 2 in. long.

The sewage enters through a 4½-ft. sewer and is regulated by "swing gates" to go onto one or more screens as the quantity requires. As the screen moves forward such of the solid matter as it intercepts is carried to its top where brushes throw it into pneumatic ejectors. The screened sewage passes into a wet well from which it is pumped to a high-level sewer which discharges into the Hudson River. Liquid chlorine is automatically proportioned to the volume of sewage and is supplied by means of six vacuum type Wallace & Tiernan chlorinators whose operations are synchronized with the pumps by means of solenoid valves which cut the chlorinators in and out as the pumps operate.

The screenings are sent by the ejector into a storage tank. This tank is directly over another ejector. When the truck is available at the street level, the material in the storage tank is sent pneumatically direct into the

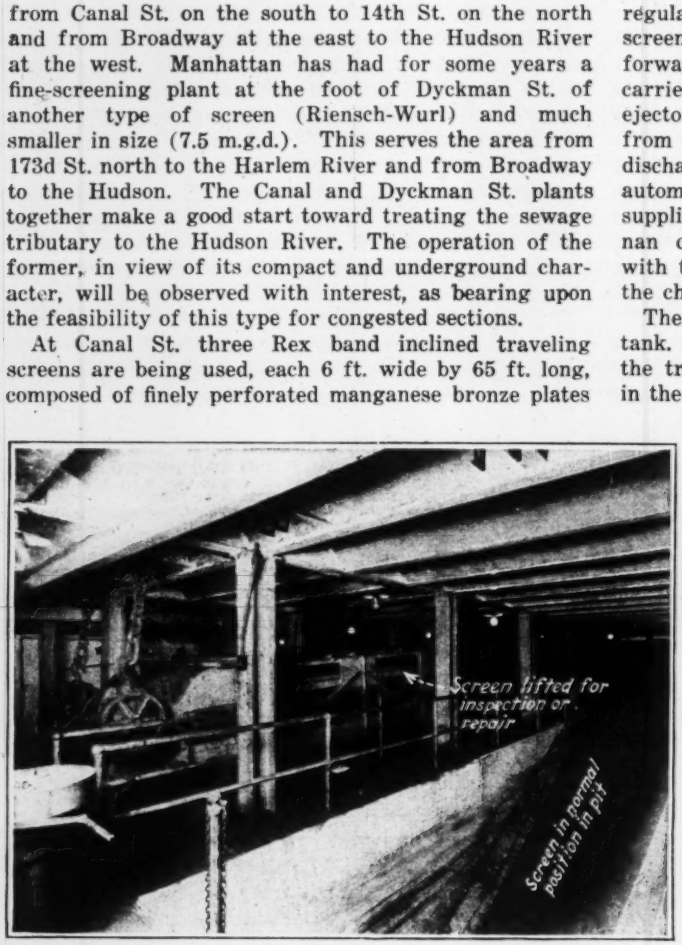


Fig. 3—Two of three band screens, each operated by a 7½-hp. motor, with speed reducer. Each screen is 6 x 65 ft., has 3/64 x 2-in. slots, and discharges screenings at the top into a pneumatic ejector.

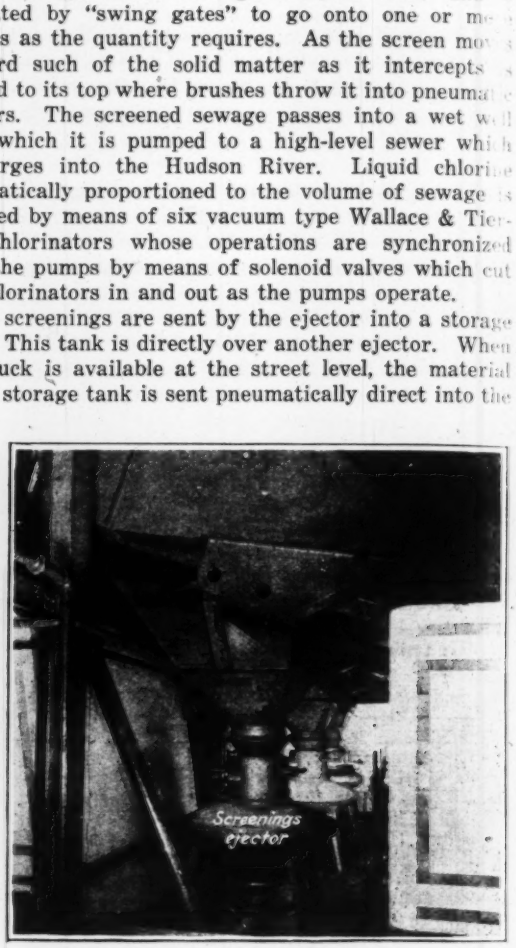


Fig. 4—A pneumatic ejector under 60 lb. pressure beneath each screen lifts screenings to storage tank, whence an ejector lifts them to a covered motor truck.

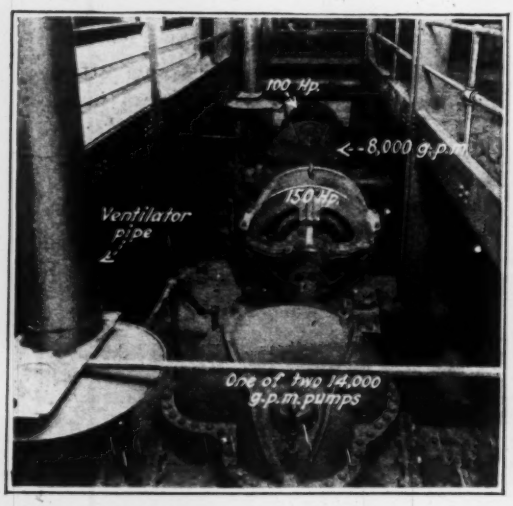


Fig. 5—Two of three motor-driven centrifugal pumps, with automatic float control lift the screened sewage for discharge into the Hudson River.

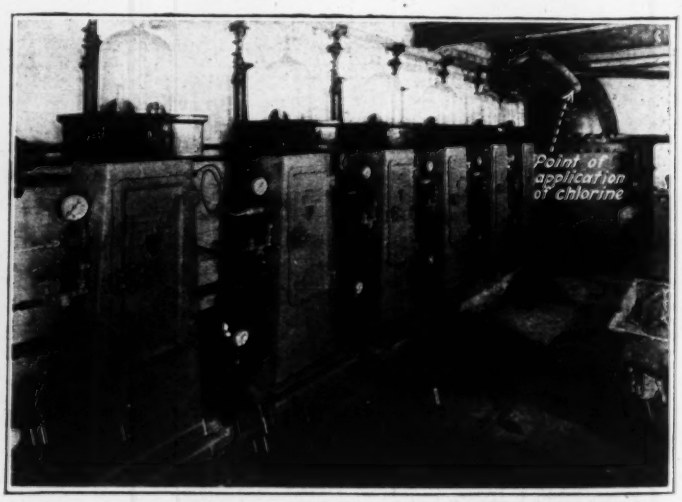


Fig. 6—Six chlorinators, each with capacity of 300 lb. per hr. of liquid chlorine, are worked in batteries of three, thrown in and out by solenoid valves as the pumps operate.

FIGS. 3 TO 6—CANAL ST. SEWAGE SCREENING, CHLORINATING AND PUMP PLANT, NEW YORK CITY

truck. The truck carts the screenings away to the dump. Negotiations are on which it is expected will result in the sale of the screenings for fertilizer.

The pumping equipment consists of two 24- and one 18-in. centrifugal pump, driven automatically by two 150- and one 100-hp. motors. A 50-hp. motor operates the air compressor for the ejectors; a 5-hp. motor runs the ventilating equipment; a 7½-hp. motor takes care of the two-ton sidewalk elevator; and three 7½-hp. motors run the screens. To heat the plant and prevent dampness and to heat the water used to clean the screens, steam is supplied by an automatic gas heated boiler.

The work was done by the Borough of Manhattan under the direction of Julius Miller, borough president, Joseph Johnson, commissioner of public works, and Clifford M. Pinckney, chief engineer, with the Riverdale Construction Co., Inc., New York City, as contractor. The construction cost was about $400,000.

Brick Paving on Water-Bearing Clay Subgrade

Central Mixing Plant Prepared Concrete and Also Asphalt Mastic Bedding Course for Vitrified Brick Pavement

BY FRANK R. ALLEN
City Engineer, Pine Bluff, Ark.

SEVERAL construction problems, whose solution presents some interesting features, were encountered last year in repaving streets in an outlying district of Pine Bluff, Ark. This city is at an elevation only a few feet above the high water level of the Arkansas River. The soil varies from heavy yellow clay through sand, sandy loam, buckshot, etc., to a silty composition that has no apparent resistance to erosive action. Underlying quicksand is encountered in many places at varying depths.

Naturally these soils offer little resistance to percolation and have a high degree of absorption. During high water the permeation reaches a maximum which continues for extended periods during the winter and spring, and during these periods considerable trouble has been had from percolation and seepage in the sand cushions of pavements. Knowing this condition, we provided for this new work a so-called "mastic cushion" composed of sharp river sand mixed with five to seven per cent of cold patch asphalt, believing that the mastic so produced would present sufficient resistance to percolation and seepage to prevent shifting of cushion.

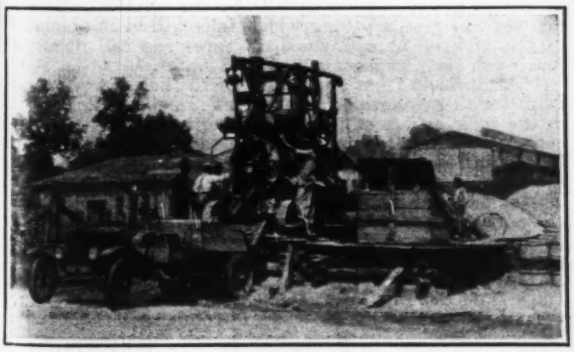


FIG. 1—CONCRETE MIXER MIXING ASPHALT MASTIC

There was considerable discussion whether it was practicable to mix the mastic in a concrete mixer. An experimental run was made and it was found that it would work perfectly. On determining this, the contractor set up an ordinary medium-sized concrete mixer in a convenient location where adequate storage space and freight trackage were available. This plant mixed the concrete for repairing the old base, for the new base work, and for curb and gutter construction as well as the mastic for the cushion.

In mixing the cushion, a cold patch asphalt was used with the sand in proportions of 4 gal. of asphalt to 600 lb. of sand, making a mixture of approximately 5½

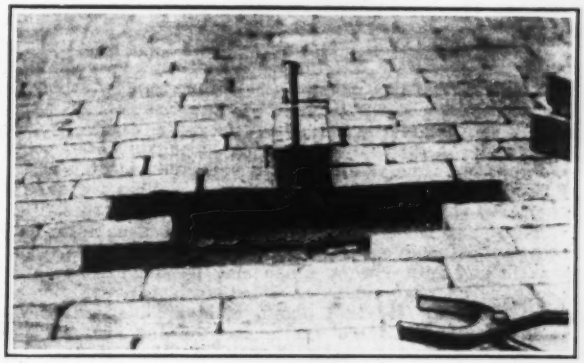


FIG. 2—CULLED BRICKS SHOW ACTION OF MASTIC BED
Bricks removed after first rolling and before pouring joints. Note condition and position of bituminous cushion materials in bottoms of joints. Rule is standard one foot stick with 3-in. "joints."

per cent asphalt. The materials were mixed cold, automatically emptied from the mixer into dump trucks and hauled a distance averaging one-half mile. The maximum haul was one mile. The material was dumped on the concrete base, spread with shovels, raked and struck with a templet in the same manner that plain sand is handled, and left to cure undisturbed for a period of twenty-four hours. Then the brick were laid and rolled. After rolling the cushion showed an average depth of ¾ in. and it was found that the mastic penetrated the joints of the brick from ¼ to ⅝ in. After reculling the brick, following this rolling, the joints were poured with an asphalt filler and the surface was sanded and rerolled.

Brick for test purposes were removed only after a great deal of work. On removal it was found that the brick were practically sealed on all sides. The finished pavement is noiseless and resilient.

Comparison of costs in the use of the mastic cushion against an ordinary sand cushion shows that the former cost ten to eleven cents per square yard additional. This cost subdivides as follows: Ashphalt 3c. mixing 3c. and spreading 4c. to 5c.

The Kaw Paving Co. of Topeka, Kan., had the contract for the work which was handled by George E. Williams, superintendent.

Water Power in Madison River Basin

Undeveloped water resources in the Madison River in Montana are estimated at 136,000 hp., by engineers of the U. S. Geological Survey in water supply paper 560-A. At the present time 18,000 hp. is being developed and irrigation has been supplied to 35,000 acres and can be extended to 40,000 more. The annual flow of the river is stated as 1,400,000 acre-feet.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Railway Surveys from the Air

Sir—I have been much interested in the letter published in your issue of March 5, p. 408, written by H. R. Faison and criticising my article in the issue of February 5 on aerial surveys and reconnaissance.

I must ask you for space enough to deprecate Mr. Faison's complaint of my lack of "enthusiasm." As a matter of fact I think my state of mind when writing was much more that of one guarding against the enthusiasm by which he was surrounded at the time—the enthusiasm of the clean-souled, single-minded young spirits with whom he was associated was decidedly contagious and having been young myself at one time and associated with and even the author of reforms and innovations from time to time I could not help being strongly sympathetic.

I am so far inoculated with the aviation virus as to have recommended and even provided for the use of a special plane in any future work which may be and I believe will be carried on next summer. I am conservative if not actually skeptical on some points and would recall to my young friends the famous utterance of one of the noted French generals (I think it was Marshal Ney) when instructing some of his subordinates "*Sur tout point de zêle.*" I think Ney would probably have used "enthusiasm" rather than "*zêle*"—if it had not been a much longer and less French word. He liked to be concise.

I must take strong exception to some of Mr. Faison's ideas among others that the Laurentian country is not "typical," or that it is "peculiarly unsuited to aerial survey." It is typical of one-third of Canada and a good deal of Northern New England and he is quite wrong as to the "particularly unsuited" clause for the Aviation Board has done some wonderful topographical mapping at very moderate cost and the forestry departments of the Ontario government and some of the larger pulp and paper industries equally wonderful work in their special lines. But this is all projection on the horizontal plane not the vertical. He is also quite wrong as to his statement that it is "impossible" to estimate the value of wooded gaps from observation from a canoe. This I have disproved over and over again. One observation of this kind from a boat resulted in the abandonment of several months' careful work by one of the ablest of the Canadian Pacific Railway Co.'s engineers and the saving of many hundreds of thousands of dollars in constructive cost.

I must make at least a reservation in respect to Mr. Faison's proposition that grades are not laid down in advance of reconnaissance. Even in the 70's, which he refers to rather contemptuously, Sandford Fleming fixed a standard for the C.P.R. in the Laurentians of 0.5 per cent in one direction and 1 per cent in the opposite and this was adhered to during his administration and for some hundreds of miles. A still higher standard was fixed and adhered to in the case of the Canadian Northern at a later date. Although some of my work dates back to the early seventies we never used any but "paper locations."

In conclusion I would point out that an aerial survey of a 40-mile canyon is a very different matter from that of 240 miles of railway line. I have personally testified to the value and accuracy of such a survey and the indifference which the plane shows to desert or swamp or lake expanse. These things are beyond argument, but there are many other considerations in a reconnaissance survey; and in the matter of time, which in the case under consideration was important, I confess to disappointment. Days, weeks even months went by and I had not the information I really wanted, much of which I got by older methods at very little expense of either time or money, but much of this loss was due to misconception on the part of my clients and the survey people as to what was really wanted and to my own inexperience as to just what they could furnish me with and how long it would take. I am wiser now and shall use the plane more as a means of locomotion and perhaps less for observation and study.

I have worked in South America and I have traveled on horseback or muleback and in motor cars and a very great number of miles on foot, and in the canoe—which Mr. Faison rather deprecates—many thousands. The latter is not as he suggests a matter of choice; it is the only practicable method in the North Country in summer except the modern one under discussion. Hence my allusions to it. In many years I have perhaps acquired an unusual facility for observation from it. Possibly if I live long enough I may develop a similar aptitude for the interpretation of momentary oblique glimpses and the resultant photographs. So may it be. I do not despair nor confess to the distorted vision which Mr. Faison attributes to me and himself. All things come to him who waits. Meantime there are some things I know and one thing is that a lake has for my purpose a level surface and another is that a barometer or as the aeronaut calls it the altometer sometimes lies like the proverbial trooper.

HENRY K. WICKSTEED.

Toronto, Ontario, Canada.
March 15, 1925.

Concrete Crack Fillers

Sir—Referring to the editorial on concrete crack fillers in *Engineering News-Record*, March 12, 1925, p. 426: The statement is made, regarding crack filler experiments of the state of Iowa, that fourteen bituminous mixtures were tried, out of which only three mixtures stuck.

We do not know whether all of the marketers of asphalt crack fillers knew exactly what their material was to be used for when they were called upon to furnish a material to the Iowa State Highway Department for test purposes. In our case the material furnished was not the grade of material that we recommend for portland cement concrete crack filler. It was our regular grade of asphalt paving filler for use in brick pavements and expansion joints and was not suitable as a surface coating or fine crack filler. We have different grades of bituminous materials for putting on paint coats or filling fine cracks in portland cement concrete pavements, and these materials vary in consistency, as we recommend different grades of material to correct defects of different kinds.

There is no question that the officials of the Iowa State Highway Department did the best they could with the materials that were submitted to them, but wo do not believe that all of the producers understood the exact purpose for which the materials were to be used. This also applies to experiments and tests that were made in other states.

We think that the problem of bituminous crack fillers and bituminous paints to seal the surface of portland cement concrete pavements is practically solved. We state this as we believe that there is possibility of an injustice being done to some of the producers of the material representing the eleven products that failed in the Iowa test.

C. C. LAKIN,
Standard Oil Co.

Chicago, Ill.,
March 31, 1925.

Attacking Sewage Bacteria by Dynamite

Sir—Some years ago a question arose in my mind as to whether or not bacteria could be killed by concussion. I was unable to get a definite answer to the question. It being my wont to give anything which falls within the bounds of reason at least a trial, since we never can tell in advance just what such trial may lead to, I had a 15x24-in. riveted steel tank made from ¼-in. plate by the boiler works. This I filled with raw sewage and sealed. Then I exploded a cap in the tank, which of itself gave quite a shock, then three caps, each time of course taking a sample to determine the change in bacterial count if any. At last I exploded a small charge of dynamite in the tank with the result that it blew my tank to smithereens but I was able to get a bottle filled to complete the series of samples. Within 24 hours after plating, all these samples showed colonies in such numbers as to be beyond count, the only difference being that there was a visible diminution in numbers between the plates made from the raw sewage and the dynamite.

I am led from this to wonder if the bacteriologists are really correct in describing these minute organisms as living protoplasm under various forms for it is inconceivable to me that anything vegetable or animal could survive that last

shock which was equivalent to putting each minute individual on an anvil and giving it a hammer blow. If they are not things of life then it might open some new way of combating them.

The visible diminution in number of colonies may indicate that some had more power of resistance than others and as the bacilli of typhoid and dysentery, etc., when carried along with sewage are out of their natural environment they may be so weak that a small jolt would kill them.

It might be worth while for some laboratory or sewage disposal department to carry this idea further for if we could render the pathogenic bacteria harmless then dilution would take care of the others and in many cases it might develop that large sums of money could be saved in construction.

T. R. HASLEY.

Menominee, Mich.,
March 19, 1925.

Public Works for Esthonian Unemployed

Sir—Not all countries have successfully solved the problem of unemployment like Norway, as cited in your issue of Oct. 16, 1924, p. 631.

As the result of an extraordinarily mild and rainy winter there is this year acute unemployment in Esthonia. In Tartu, a town with a population of 55,000, as many as 517 unemployed men and 710 women were registered Feb. 20, whereas 1,494 people were employed on relief work.

Last year the unemployed in the country amounted to some hundreds of men and the government created food-distribution points. Subsidies being considered as acting in a demoralizing manner, this year funds were voted to be paid for relief work on a day-labor basis: 100 marks to men and 90 to women (27 and 24 cents respectively in American currency), the normal day laborer's fee being twice as high. No work of broad scale being organized by the national government, the unemployment has to be fought locally. The cities get the unemployment grants for labor only, all tools and material being purchased at municipal expense.

In Tartu four gangs of 35 men each have been employed continuously on laying sewage pipes, all excavation as a rule being done by hand. Other groups are engaged on road improvement and irrigation work, but the bulk of the people are busy with excavating (by hand, of course) for a stadium on a hillside and filling up low-grade streets on the Emajögi River side. An interesting, and to Americans what will doubtless appear unbelievable, feature of this work is the moving of earth for the fill. As there is an easy slope towards the river, a Decauville track has been laid from the stadium for a distance of two kilometres downtown. The city budget containing no sums to pay mechanical haulage, thirty loaded flat cars in a row move down hill by gravity, six women and a man sitting on each. After being dumped, the cars are pushed back up the grade by the passengers.

H. SEYDENBACH,
City Engineer.

Tartu, Esthonia,
March 11, 1925.

Impact and Structural Safety

Sir—Your editorial on "Dangerous Impact Action," Mar. 19 issue, p. 464, calls attention to facts that substantiate what I have repeatedly stated publicly as to the danger of a recent tendency that ought to be checked in its incipiency. The facts concern impact, and provision in design for the effect on a structure of rolling loads.

I have repeatedly stated it as my opinion that so-called impact has nothing whatever to do with the length of bridge that is loaded. The dynamic effect of a rolling load on any part of a bridge depends on two elements. One of these is the roughness of the track or floor—the jar produced by the bumping of the load as it rolls along, including lack of balance, as in locomotive drivers. The other element is nearness or remoteness, of the member considered to the track or rail or floor receiving the load.

All tests of impact have demonstrated my thesis and in doing so have demonstrated the falsity of all impact formulas, for these formulas are based on the length of track or floor that is loaded. Modern specifications for steel bridges are based on these false formulas and are, therefore wrong. Theodore Cooper's method of making allowance for the dynamic effect of bridge loads is the only rational method ever written into specifications. It is amply verified by tests of impact, and it is substantiated on the ground of reason and common sense. Low unit stresses for sections and rivets of the floor system, and higher unit stresses for the main truss members, characterize Mr. Cooper's method. This has never been improved on.

The tendency that should be checked in its incipiency, referred to in the first paragraph of this letter, is the recent yielding of some authorities to the urge of an association of steel fabricators to raise the unit stress on steel. Over in the reinforced concrete camp they are working hard to boost the compressive unit stress on concrete to 800 lb. by making tests by the hundred thousand that ignore every other property of concrete except the absolute maximum compression attainable by means of optimum water content and fancy laboratory methods. Naturally the steel interests want to get the jobs, and the simplest way to do that seems to be to raise the steel unit from 16,000 to 18,000 or 20,000 lb., and the chief argument the absence of failures recorded on the 16,000 basis.

Failures seem to be handy things sometimes; they indicate when we are going over the top. The Quebec bridge failure in 1907 though it was due to a different cause than high unit stress, laid bare the fallacy of supporting loads on highbrow opinion. That failure put a damper on some high-handed kiting of unit stresses on large structures. I am afraid we need one on a smaller structure where the design stress of 18,000 lb. is boosted to a value above the elastic limit by the 150 per cent impact recorded by the recent tests to which you refer.

EDWARD GODFREY.

Pittsburgh, Pa.
March 24, 1925.

Designer of Muck Car Switcher

Sir—In *Engineering News-Record*, March 5, 1925, p. 403, is an article, "New Devices in the Moffat Tunnel," describing the muck-car switcher used in the work as the invention of Orren Allen. The writer was superintendent of the east portal of the Moffat Tunnel from Oct. 1, 1923, until his resignation on Dec. 15, 1924, and personally designed this muck-car switcher. As a matter of fact the application for patent is made by Allen and O'Rourke, this arrangement being a personal matter between Allen and the writer. The writer also had considerable to do with the construction of the drill carriage referred to in the article; so much so that he had to go to Denver and accept the responsibility of it by putting his O.K. on it before it was shipped. The description is misleading as it would lead one to believe there was more than one crossbar to hold the arms and drills in position, whereas only one crossbar is used.

Your files of 1913 have description of drill carriage designed by S. P. Brown, at that time chief engineer of the Mt. Royal Tunnel on the Canadian Northern R.R. at Montreal. The writer, at that time in the employ of the Sullivan Machinery Co., assisted Mr. Brown in its construction, but had nothing to do with its design. With the exception that a different method of advancing the drills to the face was used, due to the fact that after the bar carrying the drills was jacked against the side walls, the truck or car had to be removed and the beam raised to allow hand trucking, the Moffat carriage is adapted from the design of S. P. Brown.

D. J. O'ROURKE.

Chicago, Ill.,
March 23, 1925.

[Information as originally furnished by the Moffat Tunnel engineers for the article in question did not include any reference to Mr. O'Rourke, but on inquiry we have the following letter.—EDITOR.]

Sir—Answering yours of March 28, I have talked with Mr. Allen, who is just in receipt of a letter from the Patent Office. Allen and O'Rourke have just been allowed a patent upon the mucking system embodying the use of the air-hoist muck-car switcher, the idea for which was suggested by Mr. Allen and the mechanical device worked out by Mr. O'Rourke, who is a mechanical genius. The air-cylinder feature is not patented, being a common mechanical expedient, but the idea of swinging the cars to one side, which Mr. Allen claims he originated, is considered basic. The drill carriage described is universally known as the Ingersoll-Rand carriage and was made by their local agents, the Stearns-Rogers Mfg. Co. Mr. O'Rourke suggested improvements for which credit should be given.

C. A. BETTS,
Office Engineer,
Moffat Tunnel Commission.

Denver, Colo.,
March 30, 1925.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Chicago Rejects Plan to Purchase Complete Transit System

In a referendum vote the city of Chicago, on April 7, rejected by a majority of 100,000 votes the ordinance providing for a municipally-owned transit system. The ordinance called for the sale of "municipal railway certificates" and the use of the proceeds for the purchase of existing surface and elevated lines and the construction of rapid-transit subways.

The whole plan centers around the municipal railway certificates which were not city bonds nor obligations of the city but were to be secured by a mortgage upon the entire transit property. They were to bear 5 per cent interest and to mature in 30, 35 or 40 years; the interest and principal to be payable solely out of the earnings of the transit system. Fares on the system were to be so adjusted as to provide just enough to efficiently maintain and operate the system, pay interest on the certificates and meet the sinking fund requirements.

Service-at-Cost Traction Plan Rejected at Milwaukee

Milwaukee voters on April 7 rejected the traction company's plan for a service-at-cost contract providing for a neutral board of control to operate the transit system and guaranteeing the company a return of 7½ per cent upon the value of its property, the present 7-cent fare to be reduced when the profits exceeded the guaranteed return.

Lakes-to-Hudson Waterway Board Is Appointed

The board which will conduct the preliminary examination and survey of the Lakes-to-Hudson Waterway will consist of Col. Herbert Deakyne, Col. Spencer Cosby and Major Paul S. Reinecke. As instructed by Congress the board will report on the feasibility of providing depths which will permit of navigation by boats of 20- and 25-ft. drafts. The report is to be submitted to Congress not later than May 1, 1926.

Appropriation for Poughkeepsie Bridge Is Vetoed

Governor Smith, of New York, last week vetoed a bill passed by the Legislature making an initial appropriation for construction of the Hudson River bridge at Poughkeepsie, which is projected as a state enterprise. He stated that the money for the construction of this bridge should come out of a bond issue which is to be voted on by the people of the state next fall, instead of being cared for by a specific appropriation.

Engineering Fifty Years Ago

From *Engineering News*, April, 1875

Two Book Reviews

CONTINUOUS Revolving Drawbridges. The principles of their construction and the calculation of the strains in them. With more especial reference to the designing of continuous panel girders of this description. By Clemens Herschel, C.E., Member of the American Society of Civil Engineers. With 19 wood cuts and 10 Heliotype Plates. Boston: Little, Brown & Co., 1875.

Graphical Method for the analysis of Bridge Trusses; extended to Continuous Girders and Draw Spans, By Charles E. Greene, A. M., Prof. of Civil Engineering. University of Michigan. Illustrated by three folding plates. D. Van Nostrand, New York, 1875.

Two Railways Plan Extensions in Texas

Plans for the construction of railway lines to open up new territory in the northern part of Texas were announced in Fort Worth recently. The Atchison, Topeka & Santa Fe Ry. plans the construction of a 35-mile line from Plainview in Hale County through Floyd County to Silverton in Briscoe County, and a 68-mile line from Plainview through Lamb or Swisher County to Dimmitt in Castro County. The Fort Worth & Denver City Ry. also plans the construction of a line into the same territory as an extension westward from Estelline.

Pennsylvania R.R. to Make Study of Transportation Problems

During the spring and summer officers of the Pennsylvania Railroad System will make a number of investigations which will include among others a report on the relative cost of maintaining track on stone, gravel and cinder ballast, a report on the effect of automatic signals on single-track operation, and the effect of remote control switches at outlying sidings and other track. The committee on railway economics will report on a proper measure of operating efficiency and on the possibility of adopting a policy of storing coal at selected locations during the summer months to provide partially against winter consumption. Consideration also will be given to the establishing of special apprentice positions which will cover in one course all of the operating departments of the railroads.

Drayer Resigns Secretaryship of A.A.E.

Effective April 1, C. E. Drayer, for seven years secretary of the American Association of Engineers, has resigned. Miss M. E. McIver, assistant editor of *Professional Engineer*, has been made acting secretary under Harold Almert, managing director. Difference of opinion as to policy with reference to the activities of the association led to the resignation.

Mr. Drayer went to the secretaryship from Cleveland where he had gained a wide reputation for obtaining publicity for the Cleveland Engineering Society of which he was the non-paid secretary. His regular position was valuation engineer for the Nickel Plate R.R. His interest in society affairs and what could be gained for the profession by co-operative effort led him to organize the Association of Ohio Technical Societies and be one of the prime movers on the Committee on Co-Operation of Engineering Societies in the United States.

Graduated from Western Reserve University in 1902 he served in various engineering positions in the maintenance and construction departments of the Pennsylvania, Rock Island, Union Pacific and Nickel Plate railroads. In Wilmette, his home town, he still has a year to serve as village trustee.

Restrictions Removed from Sale of New York State Power

The recently-closed legislature of the state of New York passed an amendment to the law which authorized the development of hydro-electric power at points along the Barge Canal, which amendment authorizes the state officials charged with the disposal of surplus power to sell it to the highest bidder. This action clears up the situation in which these officials found themselves following the action of the previous legislature restricting the sale of this power to municipalities only, when no municipalities would purchase the power because of its character or because they were already committed to the purchase of other power by contract.

A.E.C. Administrative Board to Meet May 8-9

The Administrative Board of American Engineering Council will hold a meeting in Philadelphia Friday and Saturday, May 8 and 9, in the rooms of the Engineers Club of Philadelphia. The first session of the board will open at 10 o'clock, Friday morning. The executive committee will meet Thursday, May 7, the hour and place to be announced later. Other details as to the program which will be followed will be announced shortly.

WASHINGTON NOTES

Officials in Washington state that Chicago, in undertaking to comply with the conditions of its permit covering diversion of water from Lake Michigan for sanitary uses, is evidencing an earnest desire to comply with all requirements. Protests continue to come in from Canada and Lake cities asserting that Chicago got everything it wanted and was tremendously favored by the War Department's action, but attention is called to the fact that the permit requires a program of performance that will tax the ability of the city, particularly if local politics should prevent unity of action.

As time passes and more opportunity has been given to note the reactions of each side of the diversion controversy, the War Department is becoming more and more convinced that its plan is an equitable and promising step toward the solution of the matter.

Extension of the government's barge service to the Ohio and the upper Missisippi is being considered actively, Gen. T. Q. Ashburn, the head of the Inland Waterways Corporation has announced. The Ohio River study is under the immediate direction of Wilmer N. Jacoby of Pittsburgh. Halleck W. Seaman, of Clinton, Ohio, will direct the study of the upper Mississippi. Both Mr. Jacoby and Mr. Seaman are members of the Corporation's advisory board.

These studies are to determine (1) the state of the channels and the probable date at which common-carrier service can be inaugurated safely with prospects of successful operation; (2) the character of traffic which may be expected to be carried on these streams; (3) the location and the character of terminals which should be built, both for local use and for interchange with connections, both rail and water; (4) the type of equipment which should be employed and the approximate extent and cost of the fleets which should be provided to initiate these services.

The new attorney general is not expected to take up actively the matter of trade association statistics until the Supreme Court of the United States decides the cement and maple flooring cases. Since these forthcoming opinions may go far toward clearing up the uncertainty that now exists, the plan advocated by industry to bring test suits will not be pressed in the meantime.

One of the regrets expressed in connection with the selection of Mr. Stone for the Supreme bench was the fact that it means the departure from the Department of Justice of an attorney general who had given sympathetic and profound study to the whole question of trade association figures. His studies, however, may stand him in good stead in contributing to the decision of the cases now before the high tribunal and other cases that may reach it in the future.

The recent action of the Senate in calling on the Federal Trade Commission for a list of the open price associations is regarded as indicative of an increasing appreciation that there is a wide difference between that type of association and the regular form of trade association engaged entirely in work of a constructive character.

The War Department in the near future will advertise for bids for the lease of power at Muscle Shoals pending definite disposition of this power by Congress. Secretary Weeks has revealed that he would sell all of the available power on a short-time lease which, however, would be revocable at any time on thirty days' notice. Whether the nominal period of the lease would be for six months, a year or eighteen months would be a matter of negotiation, he said. Because of the uncertainty surrounding the action Congress may take, Secretary Weeks expressed the opinion that no company probably would feel justified in incurring any great amount of expense in transmission-line construction to get power on this temporary basis.

Colonel Spaulding, in charge of construction at Muscle Shoals, has been called to Washington to participate in the preparation of the leases.

Commission to Study Barge Canal

A temporary commission to make a study and survey of the operation and facilities of the canal system of New York State, the extent of use thereof for transportation, and the requirements for improving and developing the system and promoting and increasing the use of its facilities, was created by a bill passed by the New York Legislature and signed by the governor. The commission is to be composed of the state engineer and the superintendent of public works, three senators, five members of the assembly, and three members to be appointed by the governor. The commission is to report to the legislature at its first sitting in 1926.

San Carlos Dam Surveys Begin

Surveys and other preliminary operations required for the new Gila River dam at San Carlos, Ariz., to be called Coolidge Dam, are to begin at once, using part of the $450,000 appropriation made immediately available in the 1926 Interior appropriation act. A separate act authorized construction of this reclamation project, by the Bureau of Indian Affairs, primarily to supply water to Lima Indians living on the Gila River reservation; water will also be furnished other lands along the river.

This initial expenditure of $50,000 is to be used in perfecting plans determining the total area to be included in the project and appraising various tracts of land within this area in excess of 160 acres to be purchased by the government. A contract will be negotiated with the present water users' association, relocation of the tracks of the Southern Pacific R. R. now running across the reservoir site arranged for, and settlement made with Apache Indians for flooding their lands.

River and Harbor Fund Totalling $44,353,550 Allotted

Allotments of the funds made available for river and harbor work during the last session of Congress were anounced by the Chief of Engineers on April 1. The allocations of $100,000 or more are:

Delaware River, Philadelphia to the sea, $2,815,000; New York and New Jersey channels, $1,400,000; Hudson River, $136,000; Boston Harbor, $450,000; New Haven Harbor, $103,000; New York Harbor (Ambrose Main ship, Bayside and Gedney channels, including anchorage channel and Craven Shoal and the channel between Staten Island and Hoffman and Swinburne Islands), $400,000; East River, N. Y., $1,000,000; Newark Bay, $200,000; Delaware and Chesapeake canal, $2,500,000; Baltimore Harbor and channels, $290,000; Potomac River at Washington $114,500; Norfolk-Beaufort waterway, $447,000; Cape Fear River, at and below Wilmington, N. C., $329,400; Savannah Harbor, $720,000; Beaufort and St. Johns River waterway, $104,800; Fernandina, Fla., $235,000; St. Johns River, Jacksonville to the sea, $200,000; Tampa Harbor, $225,000; Mobile Harbor, $320,500; Gulfport Harbor and Ship Island Pass, $130,000; Southwest Pass, Mississippi River, $750,000; Sabine-Neches waterway, Texas, $1,000,000; Galveston Harbor, $215,000; Galveston channel, $412,000; Galveston-Texas City channel, $223,000; Houston ship channel, $564,500; Port Aransas, Texas, $100,000; Mississippi River between the Ohio and the Missouri, $1,550,000; Mississippi River between the Missouri and Minneapolis, $1,000,000; Missouri River, $800,000; survey of Tennessee River, $200,000; Tennessee River, dam No. 2 to Florence Bridge, $1,000,000; Ohio River, lock and dam construction $4,265,000; Ohio River, general improvement, $308,750; Monongahela River, $900,000; Allegheny River, $700,000; Keweenaw waterway, Michigan, $179,000; Fox River, Wis., $233,000; Sheboygan, Wis., $155,000; Buffalo harbor, $145,000; San Francisco harbor, $125,000; San Pablo Bay and Mare Island Strait, $200,000; Humboldt harbor and bay, $1,000,000; Coos Bay, $750,000; Columbia and Lower Willamette Rivers, $683,000; Gray's Harbor, $228,000; Honolulu harbor, $228,000; Nawiliwili harbor, $296,000; San Juan harbor, T. I., $236,600; survey of northern and Northwestern lakes, $165,000; supervision of the harbor of New York, $118,820.

The total amount allocated, including $9,316,490, reserved for contingencies, was $44,353,550.

Shoals Commission To Organize

The President's Muscle Shoals Commission will organize at a meeting in Washington April 9. The illness of the Secretary of War has delayed the advertisement of bids for the temporary use of the power. It is expected, however, that these bids will be called for promptly. It is known that the Associated Power Companies and the Union Carbide Co. will submit bids.

Non-Metals Specification Problems Discussed by A. S. T. M. Committees

New Departure Follows Successful Series of Meetings of Metals Committees—New Specifications and Much Research Work

FOLLOWING several successful semi-annual conferences of all the metals committees of the American Society for Testing Materials, the first conference of the non-metals committees was held at Philadelphia last week. The previous week was devoted to meetings of the metals committees, with results as reported in *Engineering News-Record*, March 26, p. 536. The non-metals conference included cement, refractories and ceramic committees, rubber, oil, road materials and waterproofing committees. New specifications and revisions in existing specifications were recommended, research work carried on during the past year or projected was discussed, and in the case of most committees preparations were completed for reporting at the annual meeting of the society in June. More than 200 committee men were present.

Cement—Active discussion developed over possible elaboration of the present standard specifications, to define testing procedure more precisely and enable more consistent results to be obtained in practical test work. Strength tests made by 17 laboratories were reported by P. H. Bates, covering both compression and tension tests, with a total of nearly 40 000 specimens. F. H. Jackson gave similar results from about 50 laboratories upon identical samples, supposed to be tested in accordance with standard methods. The results were so far from concordant that they were held to show the standard methods of test need more precise definition. The relation of fineness to strength also was discussed. It was recommended and the committee approved the recommendation to drop the specific gravity requirement. A manual on cement testing methods is being prepared by a subcommittee, and is expected to be in printed form shortly. The committee had referred to it the new Master Specifications for Cement of the federal government, and the subcommittees are to study their provisions for the purpose of such recommendations as the committee has to make to the government board having the specifications in charge. Another meeting of the committee will be held in New York on May 15, in preparation for the annual meeting.

Concrete and Aggregates—A subcommittee to consider and harmonize the various theories governing the design of concrete mixtures made a preliminary report, with no present conclusions. Work is in progress by other subcommittees on deleterious adulterants of concrete and the effect of various admixtures put into concrete for particular purposes. A series of co-operative tests on the weight of various admixture powders is being planned. The question of the soundness of aggregates, with reference to durability of concrete, was also discussed.

Concrete Culvert Pipe—Specifications which have been under discussion by the Joint Committee on Concrete Culvert Pipe were reported to be not yet ready for presentation to the constituent bodies.

Road Materials—A recommended tentative field method for determining moisture equivalent of subgrade soils was approved. The present tentative method of tests for consistency of concrete for pavements is to be recommended for advancement to standard. A revised form of penetration test for bituminous materials will be recommended. Strong efforts are being made to develop a standard for commercial size broken stone, slag and gravel and to reduce the present large variation of sizes in stock.

Insulating Materials—Much new work has been done on tests of insulating varnishes, but further developments are in prospect, particularly in the direction of producing films of varnish which can be tested without a base. Work is going on in the development of electrical tests of varnish in the liquid state. In tests of molded insulating material, substitution of a disk for the molded cup now prescribed for the dielectric strength test has been studied, but the cup is to be retained for the present. Extensive experimental study of the impact strength of molded materials is under way.

Radio developments are directing much attention to dielectric and power factor tests of insulating materials at very high frequencies, and new tests are under consideration. Tests that have been made on electrical porcelain indicate that a change in the details of the present standard tests is necessary, and a revision will probably be presented at the June meeting. In the field of sheet insulation a tentative air resistance test of untreated paper was recommended; other questions affecting paper, such as acidity, are still in the stage of experimental research. Methods of testing laminated sheet material were reported and were approved by the committee. Plans have been made for elaborate tests of the deterioration of sheet insulating materials; the work is to occupy most of the coming year. Studies that have been made of the transformer oils during the past year have led to starting a new investigation to compare the four like tests of oil that are now current, and here the laboratory tests will be paralleled by field tests.

Waterproofing and Roofing—It was decided that all the tentative specifications for waterproofing materials are to be recommended for advancement to standards. In the field of roofing, five new specifications were presented, and were approved for submission to the society; these are substantially in agreement with similar specifications of the Federal Specifications Board. A specification for acid resistant asphalt mastic was also approved.

Coal and Coke—A list of screen openings for tests of domestic sizes of anthracite was approved. Fineness of pulverized coal was discussed, without change in the present specifications however. During the following year research work is planned on sampling pulverized coal, sampling and sizing anthracite, determining weight and size of coke, determining moisture in large samples of coal, sulphur determination, fusibility determination.

Rubber—An adhesion test was added to the tentative specifications for rubber insulating tape. Higher grade tape was discussed, but the present single standard was retained. A proposed specification for rubber valve disks was discussed, without present action. Research work on the performance of rubber products is going on in several directions; on an abrasion test, on accelerated aging, on a flexing test for belting, and on oil and gasoline resistance.

Refractories—A report on the status of refractories in metallurgical furnace work led to discussion which will be continued at a special meeting of the committee on April 15, in Pittsburgh. Load tests of refractories were discussed; a discussion of abrasion effect and tests for abrasion resistance is expected to lead to the later development of a test. The present method for a flagging test was withdrawn. The committee plans to co-operate with the Bureau of Standards in preparing standard samples of clays.

Slate—Methods of testing slate for water absorption, which have been under preparation since last June, were adopted by the committee after discussion. Methods for flexure testing were adopted, the modulus of rupture specimen to be 12 x 1½ x 1 in., and the specimen for modulus of elasticity test 12 x 4 x ½ in. The committee plans to undertake work on hardness testing, and on the weathering of slate.

Thermometers—Several revisions and several new specifications were discussed. Special attention was given to the calibration of thermometers, and a study of this subject will probably be published later by the committee.

Arizona Resolution on Colorado Compact Withheld by Governor

Washington Correspondence

Governor Hunt of Arizona has declined to transmit to the Arizona Secretary of State the recent resolution of the legislature of that state proposing to ratify the Colorado River compact with reservations. Evidently he is intent upon placing all possible obstacles in the way of the legislation. He claims the resolution is advisory only. What may happen to the resolution apparently is of little moment as other states would feel that they would have to adopt reservations of their own or interpret those set forth by Arizona. The task of composing all of these reservations would be endless, it is believed. For that reason the general opinion seems to be that no progress has been made toward the solution of the Colorado River problem.

Arkansas Engineers License Law Becomes Effective June 11

Arkansas is the latest state to enact a license law for engineers, the law having been passed at the session just closed. It becomes effective June 11. Chief among the provisions are: an application fee of $15 is required; applicants for registration must have had four years' active engineering experience (two years of which may be compensated for by graduation from a technical school of recognized standing), and must be qualified to design and build important engineering structures; a $10 fee is required for certification (making the cost of registration $25); certificates of registration will be issued without examination until Jan. 1, 1926; annual renewal of certificates is required, the fee being $10.

Reciprocity is cared for by a section allowing issuance of certificates to non-residents upon proof of registration in another state, the cost to be $10. Corporations may practice if the person or persons in charge are registered.

Exemptions from registration are granted those practicing under 30 days in the state; non-resident consulting associates of registered engineers whose consulting work in that capacity does not exceed 30 days; employes of registered engineers or of those exempt under the terms of the act; officers of the U. S. Government and officers of the state or any subdivision thereof practicing solely as such.

Revocation of license for cause is provided for.

Engineers Discharged Following Gas-Main Break Report

Following their report upon the probable causes of breakage in a gas main in Scranton, Pa., the breakage resulting in the asphyxiation of a family of six persons, J. R. McCormack and James D. Smith, engineers in the city's employ, have been discharged by Mayor John Durkan. The engineers were connected with the city's Bureau of Mine Inspection and Surface Support and their report was to the effect that two factors were involved—mine subsidence and cold weather. The dismissal of the engineers was, according to the mayor's statement, "for the good of the service." The dismissal did not come, however, until after the engineers had refused to amend their report, the opportunity having been given them by city officials "to change their findings."

The fatal accident occurred Jan. 28 during below zero weather. A street main broke squarely across during the night, the break opening up about ½ in., but the two parts of the pipe remaining in alignment. Gas followed from the break along the seams in a house service trench and entered the house through a break in the wall. The main was only 30 in. below the street and the house connection 22 in. below the surface, or well within the frost penetration area.

Some mining had been going on under the locality in question within the last few months, but no disturbance of houses or other structures on the surface from this work could be detected. The upper coal bed, the so-called Five-Foot vein, was mined and rock-packed in 1921.

A summary of the conclusions of the engineers follows:

"We found a crevice in the trench 2 ft. 6 in: south of the point where the pipe broke. This crevice we attribute to a former disturbance when the pillars in the Five-Foot bed were removed, as the fissure only showed in the rock and did not extend to the surface. At least it was not visible on the surface when the ditch was opened.

"Our examination of the premises where the deceased family lived and the houses adjoining in the vicinity, denoted no sign of any surface subsidence.

"The water main and the service pipes were not disturbed.

"It is impossible to form any knowledge of surface levels because there is no datum, with which comparisons can be made, as the levels last taken on Acker Ave. were taken prior to the subsidence of the Five-Foot bed in 1921.

The Four-Foot bed is solid under the house and laterally about north 170 ft., south 70 ft., east 90 ft. and west 160 feet.

"We have gone very carefully into this matter, due to the fact that loss of life attended the breaking of the gas main. Because of this it was necessary to study the case from all angles, dispassionately viewing causes remote and apparent. We are firmly convinced that there were two factors, each with an effect upon the other, that caused the breakage.

"As the Five-Foot vein, the surface bed, had been previously completely mined and now is inaccessible, it is possible that there has been a further slight surface movement over this vein not appreciably noticeable on the surface at this time.

"There is also a possibility that the intense cold weather had an effect upon the gas main as it was laid but 2 ft. 4 in. below the surface, being within the frost area. The slightest movement with the pipe in this rigid state would, in our opinion, cause the breakage."

Illinois Central Gets Control of Two Lines in Southwest

Control of the Vicksburg, Shreveport & Pacific Ry. and of the Alabama & Vicksburg Ry. passed to the Illinois Central Railroad Co. when the directors of the two former companies voted to lease their property to the Yazoo & Mississippi Valley Railroad Co., a subsidiary of the Illinois Central, for 250 years. The two lines have a combined main line mileage of only 330 miles, but they have important connections and form an east and west line from Meridian, Miss., across the states of Mississippi and Louisiana to Shreveport, La., crossing the Mississippi River by ferries at Vicksburg, a region where the Illinois Central Lines are generally north and south. The V. S. & P. will give the Illinois Central an important feeder line west of the Mississippi River.

Indiana County Surveyors Put on Straight Salary Basis

By the terms of a bill enacted during the last session of the Indiana Legislature, county surveyors are placed on a straight salary basis. The law is applicable to all counties in the state having a population of more than 35,000 and less than 93,000. The county surveyor will now receive a straight salary of $3,600 a year.

The deputy surveyor may receive not to exceed $200 a month and any other assistants not more than $150 a month. Rodmen will draw $4 a day. The board of county commissioners has the right to regulate these compensations which are not to exceed the maximum stated but may be lower. The county commissioners are required to furnish the surveyor his office and supplies and instruments needed in his work. The county surveyor is to be allowed ten cents for every mile necessarily traveled.

Start on Hydro Plant to Use Head of 2,470 Ft. Announced

Work on the Balch plant in the series of hydro-electric developments being carried out on the Kings River by the San Joaquin Light & Power Co. of California is to be started immediately, according to a decision announced by that company on Mar. 26. The static head on this plant will be 2,470 ft. (2,400 ft. effective) and the initial installation will include one 28,250-kw. generator driven by a double overhung impulse wheel employing single jets.

This development is to cost about $5,000,000 and the plant is to be ready for operation Jan. 1, 1927. The plans for further developments of this company on the Kings River call for an expenditure of about $50,000,000.

No storage reservoir is contemplated for this initial installation, the diversion dam being only 65 ft. high. Later this structure is to be included in a rock-fill or multiple-arch dam, 175 ft. high. A tunnel of 12 x 12-ft. section, 19,500 ft. long which is to be built from diversion to penstock can be driven from two adits as well as from the portals, thus giving six headings.

A very favorable penstock location is available which makes it possible to develop the head mentioned in a pipe 4,725 ft. long. The upper 3,500 ft. of the penstock will be a single pipe and below this point two lines will be used. Diameters will vary from 58 in. at the top to 26 in. at the lower end of the double line. Thicknesses of metal will vary from ⅜ in. to ¾ in. in riveted steel and for heavier pressures lapwelded pipe will be used, the thickness at the bottom being 1⅛ in.

Due to space limitation in the canyon the power house is to be located across the stream from the penstock, the pipes crossing the streambed in heavy reinforced concrete anchorages. Materials will have to be hauled in by motor truck a distance of 30 miles to the powerhouse site and 40 miles to the dam site.

H. K. Fox, of the company's engineering staff, will have charge of construction on this plant.

Building Officials to Meet at Madison, Wis.

The eleventh annual meeting of the Building Officials Conference will be held at Madison, Wis., April 21-24. The tentative program has been arranged and includes the following discussions and papers on safe construction, hollow building units, fire tests, stucco, lime, sprinkler requirements, limestone requirements, walkway surfaces, fire test on steel joist construction, high points of the new Joint Committee report on concrete, an elementary discussion of the relation of external loads to internal stresses, chimney construction, strength of masonry, advantages of an appendix to a building code, principles of zoning, some applications of zoning, graphic chart of building classification, a criticism of building code arrangement, American lumber standards, lumber conditions under present practice, strength of timber, some cases of dry rot in mill constructed buildings, nature of decay in timber.

Aside from these, there will be the usual social features and trips to interesting points in and near Madison, the principal one being a visit and inspection of the U. S. Forest Products Laboratory.

New Mississippi River Bridge for Santa Fe Ry

Approval of the construction of the new Mississippi River bridge at Fort Madison, Iowa, by the Atchison, Topeka & Santa Fe. Ry., has been granted by the War Department, and authority to proceed with the work has been issued by the president of the railway company. The contract for the superstructure has been awarded to the American Bridge Co. and bids for the substructure have been called by A. F. Robinson, bridge engineer of the Santa Fe System. This is to be a double-track structure, a little distance from the present single-track bridge.

Licensing Bill Fails in Kansas

A licensing bill with the usual provisions for the registration and licensing of engineers and surveyors failed to pass at the recent session of the Kansas Legislature. The legislature ended its sessions before the bill was reported out of committee.

Suburban Traffic at New York to Be Studied by Commission

A commission to study and report upon suburban passenger transportation problems of the city of New York and its environs was authorized by the New York Legislature at its recent session. The commission is to be composed of three members appointed by the governor, four by the president of the senate, and four by the speaker of the assembly. Its members are to serve without compensation, but may employ engineering and clerical forces to carry on its work. The sum of $10,000 is appropriated for the work of the commission.

Random Lines

WE'LL ALL BE ENGINEERS BYE AND BYE : By Collier

I SEE THET TH' LIFE INSURANCE PEOPLE HEV GONE INTER TH' ENGINEERIN' BUSINESS. JOE FARREN GET IN UH LETTER. "I PLACE AT YOUR DISPISAL OUR ENGINEERIN' FACILITIES."
CARTOON ENGINEER
APPAREL ENGINEER
RAGS! OLE CLO!
ASH ENGINEER
LIGHT CARRIAGE ENGINEER
FABRIC ENGINEER
RIBBON COUNTER
PLATTER ENGINEER
CALF SKIN ENGINEER
SHINE 10¢
PRODUCTS ENGINEER

Boston Post

Fiction Engineer — What the Century Co. calls a book reviewer or "critical essayist" in seeking sales for a recent novel, "Life and Erica," by Gilbert Frankau.

Appearance Engineer—Just a beauty expert, as the *Illinois State Journal* explains, in a three-column layout showing the mechanics of cleaning one's finger nails.

Psychological Engineering—Its function is to increase personal efficiency and happiness by systematically eliminating friction and inharmony. If you have a problem, mental, moral or physical; your own, your children's or your employees', we will show you the fundamental principles through which all problems are adjustable. And assist you in properly applying these principles to your individual case.—

The Bureau of Psychological Engineering

—Ad in Los Angeles *Times*.

"The hands of Esau but the voice of Jacob — fundamental principles, problems, increased efficiency and eliminated friction, lingo just like that of the engineer. Is it that imitation is the sincerest form of flattery?" asks D. D., Inglewood, Calif.

Harbor Works of $5,000,000 for Canary Islands

The Spanish Government has again approved the project for enlarging La Luz Harbor, at Las Palmas, Canary Islands, according to consular reports to the Department of Commerce. The project includes extensive construction of breakwaters, piers, warehouses and related structures calling for an expenditure of approximately $5,000,000. As this project has been approved and disapproved and revised frequently during the last decade, the present report calls attention only to the fact that it has been approved again. It is understood that no appropriations have been made and also that foreign firms will have the opportunity of financing and executing the project.

Ontario Hydro to Build Plant on Ottawa River

Premier Ferguson has announced to the Ontario Legislature that the government had authorized the development of power by the Provincial Hydro-Electric Power Commission at Rocher Fondu on the Ottawa River near Arnprior. The development, with storage, will provided 66,000 hp., and with the present minimum flow will produce 45,000 hp. It is estimated that the work will cost over $5,000,000.

The commission proposes to construct the power plant on an island on the Quebec side of the river. As the stream is the interprovincial boundary at this point, the arrangements are subject to negotiations with the Province of Quebec.

Notable Foreigners Delegates to Conference on City Planning

Among the notable foreigners who are expected to attend the International Conference on City and Regional Planning to be held in New York City April 20 and 25, are: Raymond Unwin, chief architect to the British Ministry of Health; M. Karamat Ullah, chief engineer, H.E.H. The Nizam's Public Works Department, Hyderabad, Deccan, India; Dr. Cornelius Gurlitt, president of the German Town Planning Institute; Prof. Dr. Ing. Ernst Vetterlein, director, Town Planning Department, Hanover University, Hanover, Germany; G. L. Pepler, past-president of Town Planning Institute, chief technical officer, Town Planning Department of the Ministry of Health, Great Britain; Dr. Ing. Joseph Brix, professor, Technical High School, Berlin-Charlottensburg, Germany; Dr. Plato E. Drakoules, representing the Hellenic Government, Athens, Greece; Ludwig Lemmer, alderman and city engineer, Remsheid, Germany.

Information regarding the conference may be obtained from Flavel Shurtleff, 130 East 22nd St., New York City.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Cincinnati, Ohio, April 21-24, 1925.

AMERICAN WELDING SOCIETY, New York City; Annual Meeting, New York City, April 22-24, 1925.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Louisville, Ky., April 27 to May 2, 1925.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Convention, Chicago, May 12-14, 1925.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Orlando, Fla., June 2-5, 1925.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 22-26, 1925.

The Texas Division of the Associated General Contractors has elected the following officers: Louis W. Hickey, of Dallas, president; Thomas M. Murray, Houston, vice-president; and Thomas S. Byrne, Fort Worth, secretary-treasurer.

The Western Society of Engineers at its April 8 meeting had a talk by Harry F. Ferguson, chief sanitary engineer of the Illinois State Department of Health, on "Southern Illinois After the Tornado."

The Philadelphia Section of the American Society of Civil Engineers held its annual dinner March 13 with 78 in attendance; George T. Seabury, secretary of the society, gave an address on its work with particular reference to the secretary's duties. Daniel E. Moran, consulting engineer, New York City, gave a talk on early foundation work in the West.

The Affiliated Technical Societies of Boston will hold their annual dinner April 29. The program will be announced soon.

The Brooklyn Engineers' Club on April 23 will have an illustrated talk about "The Articulated Car" by W. G. Gove, superintendent of equipment of the Brooklyn-Manhattan Transit Corporation.

The Engineers' Society of Western Pennsylvania had as a special paper at its March 16 meeting "Some Influences of Contemporary Engineering on Motor Car Development," by W. R. Griswold, engineer of analysis and design, Packard Motor Car Co., Detroit, Mich.

Personal Notes

W. S. J. WICK announces that his company, W. S. J. Wick Co., Inc., has established offices at 32 Broadway, New York City, as engineers and architects specializing in the design, construction and supervision of apartment buildings, lofts, mercantile buildings, warehouses and manufacturing plants.

W. E. YORK, of Mendenhall, Miss., has been appointed county engineer for Simpson County, Mississippi.

RICHARD W. HARR of Chevy Chase, Md., a senior in Sheffield Scientific School, Yale, has been awarded the Thompson-Starrett prize of $2,500 for work of exceptional merit in the course of building construction and for promise shown as a practical building constructor. Mr. Harr is the first recipient of the prize, established by Mr. and Mrs. Louis J. Horowitz of New York City.

CLAUDE C. MASON, who has been assistant county engineer of Marion County, Indiana, has resigned from that position and is now first assistant city engineer of Indianapolis.

RALPH E. COOMES, formerly of East Longmeadow, Mass., has entered the office of the Vaughan Engineers, Boston, Mass., and will be engaged on hydro-electric development design.

PAUL MCGEEHAN, civil engineer, Kansas City, Mo., has been appointed city engineer of Kansas City succeeding ROBERT W. WADDELL, who has resigned. Mr. McGeehan was at one time engineer in charge of the sewer division of Kansas City. He designed the Turkey Creek division project. He also served on highway work at Kansas City. He was at one time senior civil engineer of the Interstate Commerce Commission on valuation of railways, having previously worked on railroad location and construction in the West and in Mexico, and on canal location for United States reclamation projects. Mr. McGeehan was born in Youngstown, Ohio, and is a civil engineering graduate of the University of Kansas.

W. R. HOLWAY, Tulsa, Okla., has been appointed consulting engineer for the Oklahoma State Board of Health. The first problem is the regulation and policing of the Spavinaw Creek watershed for Tulsa and other water supply reservoirs in the state. A thorough systemizing of the board's supervision over water and sewage plants is contemplated.

EUGENE T. THURSTON has resigned as secretary and manager of the General Contractors of San Francisco, Inc., and has resumed private practice as consulting engineer with offices at 57 Post St.

ARTHUR C. TOZZER, vice-president in charge of its Boston territory since 1919, has been elected a director of the Turner Construction Co., New York City. Mr. Tozzer began service with the Turner organization in 1905 as superintendent on the Kenyon factory building in Brooklyn and since that time has directed many important building projects including the Bush Terminal buildings and the Army Supply Base in South Brooklyn where 100 acres of concrete floor were poured in 100 days.

Obituary

DANIEL W. PAINE, a pioneer irrigation engineer, died at his home in Denver, Colo., March 22, aged 72 years. Mr. Paine was a native of Michigan but went to Colorado in 1873.

DR. JOHN N. HURTY, Indiana health commissioner since 1896, died March 28 in Indianapolis aged 73 years. Dr. Hurty was formerly president of the American Health Association.

SIR WILLIAM ACWORTH, British authority on railway economics, died in London, April 2, following a short illness. Sir William was born in England, Nov. 22, 1850, and was educated as a barrister. In 1906 he served on the vice-regal commission on Irish railways, and in 1916 on the Royal commission of inquiry into Canadian railways. Following the close of the work of this commission, he testified before the United States Interstate Commerce Commission on the subject of government ownership of railways. Sir William was the author of a number of books on railways and railway economics.

COL. WILLIAM J. OLIVER, Knoxville, Tenn., manufacturer and road and railroad builder, died at his home March 29. He was one of the bidders on the Panama Canal and while he did not get the contract he furnished much of the material and equipment for the work. He built many miles of railroad and highways in the South, being connected with the initial plan of the Memphis-Bristol road.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Sheet and Tin Plate Makers Send Out Simplified Lists

To promote wider use of the simplified sizes of sheet steel which were adopted at a conference of manufacturers, distributors and users last October in Atlantic City, the National Association of Sheet and Tin Plate Manufacturers is sending out in printed form the list of all such sizes to those interested. The simplified list which was adopted after surveys by the association and with the co-operation of the Division of Simplified Practice, Department of Commerce, represented an elimination of more than 1,550 size and thickness variations of steel sheets. The 263 retained sizes represented a large proportion of the demand.

As a sequel to this action, the Division of Simplified Practice has been informed, the association is receiving many requests for the recognized list. At the same time it is receiving many constructive suggestions for further simplifications. These are being passed on to the board of review, or standing committee of the entire industry. The findings of the board of review will be considered at the semi-annual meeting of the metal branch of the National Hardware Association of the United States, which will be held in Cleveland in May.

Martin Company Plans Quantity Production of Semi-Trailers

The Martin Fifth Wheel & Trailer Co. of Springfield, Mass., will this year make 10,000 semi-trailers and by reason of this quantity production will be able to sell them at a price proportionate to the Ford truck. C. H. Martin, president of the company, says that a careful investigation of the potential trailer market has shown conclusively that there is a practically unlimited demand for trailers but they must be produced in such quantities as will make it possible to sell them at Ford prices.

As a result of this investigation of the market possibilities and the cost of production on a quantity basis the Martin company has decided to build 10,000 trailers this year to sell for $380, compared with $650, the cost of a trailer today.

Mr. Martin says there are 30,000 lumber dealers alone using from one to 100 trucks and teams each and the semi-trailer is especially suited to their business.

This is the first attempt at quantity production in the trailer field and the Martin company believes the market is ripe for such a piece of equipment. The Martin company plans an extensive advertising campaign and will put out a large force of salesmen with demonstrators.

Concrete Road Yardage

For February the yardages included in concrete pavement contract awards were, according to reports to the Portland Cement Association: 3,787,192 for roads; 1,201,224 for streets; and 58,723 for alleys; or a total for the month of 5,047,139 sq.yd.

The accompanying table summarizes the statistics available to date.

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1925

Month	Roads	Streets	Alleys	Total All Classes
Jan.....	3,474,421	963,256	75,236	4,512,913
Feb.....	3,787,192	1,201,224	58,723	5,047,139
Total...	7,261,613	2,164,480	133,959	9,560,052

Treasury Department Recalls Shingle Marking Ruling

Washington Correspondence

Recalling a contrary decision before it had become effective, the Treasury Department has issued a ruling that imported shingles and flooring planks need not be individually marked as to the country of origin, but that marking each bundle or bunch will be considered sufficient.

In its original ruling, issued ten days previously, the Department had held that shingles and flooring planks must be marked individually, a requirement which would have considerably increased the price of such imported commodities. This original ruling was based on the dictum of the Board of General Appraisers to this effect. Because of the change of practice involved, the Department gave 30 days grace before making this ruling effective. After reconsideration, however, the Department recalled this ruling and issued another declaring that to mark each bundle or batch will be sufficient. The revised ruling was issued because the Board of General Appraisers went outside the question before it when it gave the opinion that individual marking should be required. The question before the board was whether any marking at all was necessary, the case being a bundle which was not marked.

Millwork Simplification Studied

Simplification of the wide variety of stock sizes of sashes, doors and windows used in the northeastern states into a comparative few standard sizes was recommended at a meeting of the executive committee named for this purpose by the associations and groups of the millwork industry in this section with William A. Gately, representing the Division of Simplified Practice of the Department of Commerce, at New York City March 20.

The recommendations will be submitted to a general conference of producers, distributors and large consumers to be held at Washington April 30, according to present arrangements.

If adopted, the program will mean a large reduction in sizes and uniform dimensions which is expected to result in considerable savings to building owners as well as to the industries involved. The subject has been under consideration for some months and has been presented to the various associations by Mr. Gately, resulting in the creation of the executive committee which has taken definite steps toward attaining the objects.

Business Notes

WARREN MACHINE WORKS, Baldwinsville, N. Y., has recently furnished to the city of Boston a 36-in. double suction sewage pump directly connected to a 500-hp. Diesel engine manufactured by the Nordberg Manufacturing Co., Milwaukee. The installation is for the Charles St. sewage pumping station.

WALWORTH MANUFACTURING Co., Boston, announces the formation of the engineering products division to cooperate with the engineering, production and sales departments of the company on the development and distribution of the new Walworth Sigma Steel Valves and fittings for power plant and oil refinery service. John M. Olmsted has been appointed general manager of the division with headquarters in Chicago, and Fred W. Duemler, assistant manager, located in New York.

HOOSIER ASPHALT Co., Alexandria, Ind., has appointed John L. Elliott, formerly city engineer of Indianapolis, as general manager.

LINK BELT Co., Chicago, Ill., has appointed B. M. Weiss, sales engineer, Philadelphia, exclusive agent for the Philadelphia district, from Trenton, N. J., west to Harrisburg, Pa., including the states of Maryland and Delaware.

DE LAVAL STEAM TURBINE Co., Trenton, N. J., acting jointly with the De Laval Separator Co., Poughkeepsie, N. Y., has appointed the Turbine Equipment Co. of New England, 80 Federal St., Boston, Mass., as agent in New England for the sale of steam turbines, centrifugal pumps and blowers, double helical speed reducing gears, worm reduction gears, hydraulic turbines, flexible couplings and oil purifiers. The president of the new Turbine Equipment Co. is F. R. C. Boyd who was connected with the former representative, Power Equipment Co. for fifteen years.

UNIVERSAL CRANE Co., Cleveland, Ohio, has appointed the Factory Products Co., 204 Oliver Bldg., Pittsburgh, Pa., as its representative in the Pittsburgh territory. W. W. Adams, president of the Factory Products Co., has been identified with the sale of locomotive cranes in that section since 1907.

ALLAN M. CULLUM, who has been in the mills of the Reading Iron Co., Reading, Pa., since he left Yale Scientific School two years ago, has recently

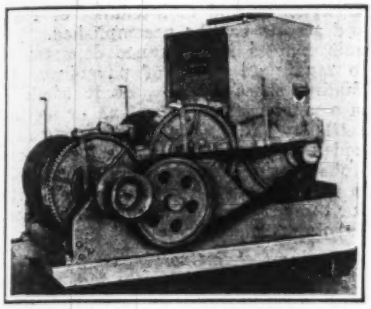
been made a member of the sales force. His headquarters will be the general office of the company at Reading.

T. L. SMITH Co., Milwaukee, manufacturer of concrete mixers and pavers, has appointed the Dixie Culvert Manufacturing Co., Little Rock, Ark., and the Standard Building Supply Co., Shreveport, La., as its representatives.

Equipment and Materials

Double-Drum Hoist

The C. H. & E. Mfg. Co., Milwaukee, is placing on the market a double-drum hoist with four-cylinder engine mounting. In the construction of office buildings or where steel is placed it is

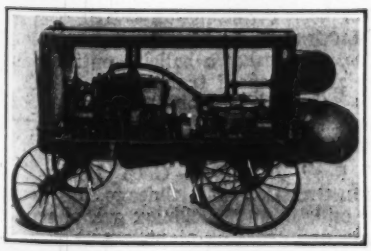


claimed that this hoist will do the work with great speed and less cost than a steam or electric-driven outfit.

In the operation of an Insley steel mast hoist, the concrete bucket can be hoisted on one face of the mast with one drum and at the same time a material elevator can be hoisted on the other face of the mast with the other drum. A hand-operated accelerator is provided so that the engine can idle slowly between loads and the speed be instantly increased when picking up the load. The engine can also be throttled down as the load approaches the top.

Vibration Minimized in 220-Cu.Ft. Portable Compressor

An angle type portable gasoline compressor with a capacity of 220 cu.ft. of free air per minute has been put on the market by the Sullivan Machinery Co., Chicago. As in the 110-ft. models, the same size of cylinder has



been utilized in the new unit—5¼-in. diameter by 5-in. stroke, single acting. However, there are four of these cylinders, and instead of being arranged in a vertical line, they are in pairs, each pair being at right angles with the other, thus forming a 45-deg. angle with the vertical axis of the machine, giving a balance which minimizes vibration.

The pairs of cylinders are slightly offset lengthwise, which permits operation from a single crankshaft. There are only two crankpins, but each pin accommodates two connecting rods placed side by side. The rods for the two forward cylinders are attached to one pin, and those for the two rear cylinders to the other. Counterweights are provided on the crankshaft as in the case of the 110-ft. portable machine.

This new compressor employs the standard Sullivan wafer valves, providing short lifts, but wide port openings. The power plant is a 43-hp. four cylinder Buda gasoline engine with a rated speed of 800 r.p.m. at full load.

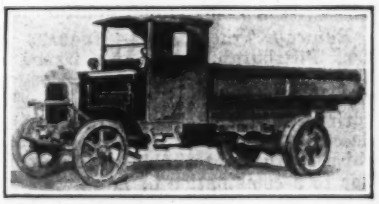
Engine and compressor are firmly bolted to a substantial cast steel frame, the total weight of the unit being 5,360 lb.

New Motor Truck Models

Designed especially for use by contractors and engineers, two new models have been added to the line of motor trucks manufactured by the Atterbury Motor Car Co., Buffalo, N. Y. The Highway Express is a 1½-2-ton truck weighing 4,750 lb. and having a speed of 30 miles per hour. Its power plant is a 4x5¼-in., four-cylinder Buda motor. The truck has a wheel base of

12 ft. 6 in. and carries a 12-ft. body. Small diameter balloon tires and steel wheels are standard equipment.

The other new model is the Highway King, with a capacity of 5 to 7 tons,



two-range transmission, and a speed of 16½ miles per hour. Two lengths of wheel base, 14½ and 17 ft., are offered. The motor is a 40-hp. Continental four-cylinder unit. The chassis weight is 9,500 lb. and the body weight allowance 2,500 lb. In this model the transmission provides seven speeds forward and two reverse.

Dunbar Drag Clam Bucket

The Dunbar drag clam, recently put on the market, is a patented bucket which combines the hard digging qualities of a dragline bucket with the tight closing features of the clamshell. It is suited to any class of work where dragline equipment can be used, such as reclamation work, the construction of dikes and ditches, earth dams, em-

bankments and canals. It also lends itself to the excavation of gravel pits and the stripping of soil from quarries and mines.

The drag clam fills quickly because it enters the bank at a sharp angle. The pull of the drag line is exerted in a manner that obtains the maximum load with the shortest drag. With a full load in the bucket, the lift begins. The strain on the hoisting line causes the arm to raise, which in turn crowds into the bucket all the material between the movable jaw and the cutting edge.

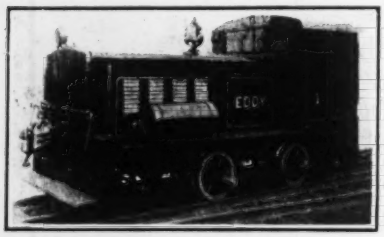
The drag clam is easy to operate. It requires only a hoisting line and a drag line. In carrying the load the drag cable is slack. There is no strain on either equipment or operator and no stop for friction clutches to cool. The load can be dumped wholly or partially by a steady pull on the drag line.

13-Ton Locomotive Has Standard Airbrake Equipment

Announcement is made of the manufacture by the Vulcan Iron Works, Wilkes-Barre, Pa., of a 13-ton standard-gage, gasoline locomotive for the E. B. Eddy Co., Hull, Inc., Canada, a paper and pulp manufacturer. This locomotive is provided with Westinghouse airbrake equipment, and is claimed to be the smallest unit of this type thus equipped. It was considered necessary, however, on account of the heavy grades and the slippery condition of the track in winter. Of particular interest is the fact that the airbrake apparatus can be instantly released from service, if necessary, and the auxiliary hand brake used.

This 13-ton locomotive is equipped with spring draft rigging, both front and rear. This feature is provided to absorb the shocks encountered in coup-

ling to heavy standard-gage cars, thereby protecting the running gear and motor and assuring longer life for the locomotive. The cab is of Vulcan standard construction, made of steel and specially adapted to cold weather conditions. The cab has sliding doors at rear and left side and all windows are adjustable, affording comfort under all climatic conditions. A heater is also provided in the cab for use in cold weather. The whole design and construction follows the company's standards and steam locomotive practice is



followed wherever possible. Frames are of open-hearth cast steel, and wheels have cast-iron centers with steel tires. The locomotive is equipped with a 110-hp., six-cylinder, Climax engine and transmission is the Cotta constant-mesh type, giving four speeds forward and four reverse. The manufacturers' ratings for tractive forces and speeds are as follows: 2 m.p.h., 7,800 lb.; 3.56 m.p.h., 6,500 lb.; 5.9 m.p.h., 5,100 lb.; 10.5 m.p.h., 2,800 lb.

This same design is offered in 15, 20 and 25-ton sizes.

Compressor for Fordson Drive Has Design Refinements

The Buhl Co. of Chicago has added a new air compressor unit to its line of portable and stationary compressors of particular interest to those who have use for Fordson tractors. The unit known as the "Buhl" type 100-FD consists of a vertical hopper-cooled twin-cylinder compressor. The tank and all fittings are mounted on a U-shaped cast-steel frame which connects with the

axle housing of the Fordson, giving rigidity, but allowing for a vertical motion. The trailer wheels are knuckled and connection is made to the steering mechanism of the tractor. With this method of control, both tractor and compressor can be turned as a unit body. Because of the way in which these units can be handled, a permanent belted connection can be maintained.

In addition to the marketing of a new unit, a few new improvements have been added to the "Buhl" types 55-90-180-C portable air compressors, such as a cast-steel protection guard for the radiator fan, removable steel housing for the engine and compressor, and a protection cover for the valve rods, rocker arms, and valve springs.

Publications from the Construction Industry

Hoists and Derricks — AMERICAN HOIST & DERRICK CO., St. Paul, Minn., has just issued Catalog 110, in the 142 pages of which are depicted the various models of hoists, derricks, scraper elevator engines, winches and buckets manufactured and put on the market by this company.

Buckets — BLAW-KNOX CO., Pittsburgh, Pa., in an 8-p. booklet, tells of the advantages of using its line of buckets. The Dreadnaught, it points out, is particularly useful in handling ballast, concrete aggregates, packed or frozen ores out of cars, digging hard packed sand and earth or dredging under water. The single line bucket eliminates hand labor in unloading cars.

Steel Mine Timber—CARNEGIE STEEL CO., Pittsburgh, Pa., has printed the eighth edition of its booklet "Steel Mine Timber," containing data and tables that reflect the practical experience gained from many years of observation in the design and installation of many miles of steel timber in rooms and headings.

Lime—NATIONAL LIME ASSOCIATION, Washington, D. C., has issued a handy sized, 24-p. bulletin, "The Binder in Your Wall," which presents a summary of the latest information on lime mortar. It is well illustrated and contains material of interest to all who build with brick or stone. The architect will be interested in the short form specification clauses, suitable for direct incorporation in his master sheets, and the contractor will welcome the handy tables as well.

Railroad and Contractors' Tools—WARREN TOOL & FORGE CO., Warren, Ohio, has a new 48-page catalog of its "Quikwerk" tools; picks, mattocks, hoes, tamping bars; crow, claw and lining bars; sledges and hammers, rail and tie tongs, chisels and punches.

Railway Track Tools—HUBBARD & CO., Pittsburgh, Pa., have issued a 34-page catalog of picks, bars, sledges, wrenches, chisels, rail tongs, etc.; also spring nut-locks. A separate folder describes a new "super-steel" track chisel with unbreakable cutting edge due to a combination of hardness with toughness.

Motor Section Cars — FAIRMONT RAILWAY MOTORS, INC., Fairmont, Minn., issues a 66-page set of bulletins bound in cover and descriptive of motor cars for section gangs, roadmasters and track inspectors; also trail cars for carrying supplies or extra men. Roller-bearing steel wheels used on these cars are described in a separate 10-page bulletin.

Brick Pavement — NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION, Cleveland, has issued four new illustrated pamphlets dealing with the construction of brick pavements for city streets and country highways. One of the pamphlets describes the process of making paving brick; the second deals with the durability of brick pavement, giving comparative figures on maintenance costs; the third contains a brief history of brick pavements and the paving industry; while the fourth is an engineer's report on certain paving investigations.

Road Building—YUBA PRODUCTS CO., San Francisco, has just issued a 16-p. pamphlet describing the Yuba Rodebilder, in which it is claimed that the machine finds traction in mud or sand, yet does not harm the surface of finely finished roads and that it is specially suited to side-hill work, plentifully powered and easily controlled.

Road Repairing—LITTLEFIELD BROS., Cincinnati, Ohio, publishes a 32-p. booklet descriptive of the Andresen road repair outfit, which shows how by the use of this equipment proper construction and maintenance of roads and streets can be accomplished. The unit enables maintenance departments to repair all types of pavements, including sheet asphalt, as it combines in a single device a heating or melting kettle, two large bins for heating sand and stone, two small bins for cement, stone dust or stone chips, a combination mixing pan and tool carrier, a heater for tampers and smoothers, and a coal-burning furnace.

Paving Grade Crossings—W. S. GODWIN CO., INC., Baltimore, Md., tells in an 8-p. booklet how the use of Godwin steel paving guards insures safety, long life and economy in original cost and upkeep in railroad grade crossing construction.

Science in Industry—PORTLAND CEMENT ASSOCIATION, Chicago, has published a pamphlet, "When Science Goes to Work for Industry," telling of the accomplishments of the Structural Materials Research Laboratory at Lewis Institute, Chicago. The story is told of the thousands of tests made in mixing and curing concrete, with the result that a better and more durable product has been made possible.

Water Filters—GRAVER CORPORATION, East Chicago, Ind., has issued a bulletin on pressure type water filters, describing filtration methods and showing the construction of the Graver filters, which are furnished with a perforated strainer plate instead of pipe manifold and strainer heads for the collection of filtered water. Complete tables of sizes and capacities are given.

Power Transmission — HILL CLUTCH MACHINE & FOUNDRY CO., Cleveland, Ohio, publishes a bulletin on its industrial type speed transformer, which, it is claimed, eliminates cumbersome speed changing devices, saves power losses, and takes up very little space.

Road Building — GOOD ROADS MACHINERY CO., INC., Chicago, has issued a bulletin on the Climax gravel screening and crushing plant, a new piece of equipment to handle and prepare road material, especially in places where boulders are found in sizes and quantities that cannot be used in the construction of the usual types of permanent roads.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Building Materials Plentiful —Steel Output Declining

Movements of Cement, Lumber, Brick, Etc., Gaining In Volume—Production Being Adjusted to Actual Demand

The tendency to purchase for actual needs only and the careful avoidance of the piling up of excessive reserve stocks, are the two principal features of the current markets in all basic materials.

While the present buying policy serves to inhibit the growth of the "boom" that may have been anticipated by some, at the beginning of the year, it also guarantees immunity from any such a liquidation of undesirable inventories as occurred four years ago.

Reports regularly received by *Engineerng News-Record* on conditions of basic building materials stocks at mills and warehouses throughout the country show that stocks of all materials in this category are consistent with demand and sufficiently heavy to prevent any abrupt advance in prices.

Movements in four of the most important materials follow:

Steel—The ingot output is reported as having fallen off considerably during the past two weeks. The present rate of operations in the steel mills is about 85 per cent of capacity, for the Pittsburgh and Chicago districts, as against 88 per cent in March and slightly over 89 per cent during the first two months of 1925.

Cement—Latest available figures show the seasonal increase in shipments which usually begins in February and continues until the end of October. The following figures are according to the Geological Survey:

	Production Thousand Barrel		Shipments Thousand Barrel	
	1924	1925	1924	1925
Jan.	8,788	8,916	5,210	5,108
Feb.	8,588	8,255	5,933	6,015
March	10,370	....	8,995	....

Stocks on hand at mills throughout the country, at the end of each month, were:

	1924 Barrel	1925 Barrel
January	14,155,000	17,656,000
Fe ruary	16,815,000	19,897,000
March	18,189,000	.....

Lumber—The following table compares the national lumber movement as reflected by the reporting mills of seven regional branches of the National Lumber Manufacturers' Association:

	Week of Mar. 28 Ft. b.m.	Corresponding Week In 1924 Ft. b.m.	Preceding Week in 1925 Ft. b.m.
Production	245,095,659	237,895,345	244,938,301
Shipments	245,620,639	239,352,927	223,821,095
New Business	247,987,967	217,350,319	228,144,501

The following figures compare the movement for the first thirteen weeks of 1925 with the same period in 1924:

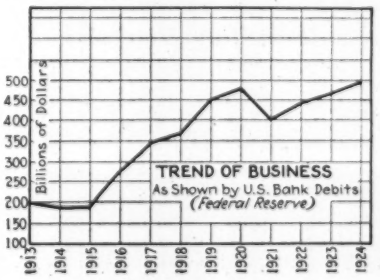
	Production	Shipments	Orders
1925	2,946,481,984	2,917,600,202	2,815,204,658
1924	2,981,740,392	3,048,913,490	3,025,335,306
1925 decrease	35,258,408	131,313,288	210,130,648

Brick—The situation as of March 1, 1925, is shown in the following tabulation of figures from the Common Brick Manufacturers' Association of America:

1924	Burned Brick on Hand M.	Unburned Brick on Hand M.	Brick Moved from Yards During Month M.	Orders on Books M.
Jan. 1	313,696	55,646	66,199	266,914
Feb. 1	306,503	38,349	45,762	272,403
March 1	282,813	39,695	104,663	263,219
1925				
Jan. 1	354,477	51,162	118,759	202,906
Feb. 1	279,862	23,951	94,185	201,479
March 1	305,831	34,891	110,790	247,176

Car Loadings and Check Payments Show Heavy Trade Volume

That the trade trend has been upward since 1921 but not so abrupt as that between 1915 and 1920, is clearly shown in the accompanying illustration.

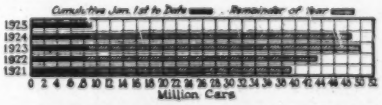


The figures, platted, form an index of the turnover of money in payment for goods or services received and consist of the following: Payments by check against accounts of individuals, firms, corporations and the U. S. Government; debits against savings accounts; payments from trust accounts; payments of certificates of deposit, cashier and treasurer checks issued by firms or corporations.

Latest available bank debits (Federal Reserve) follow:

	1925	1924
January	$49,959,035,000	$41,508,464,000
February	41,495,772,000	37,397,792,000

A chart of freight loadings prepared by the American Railway Association follows.



The tremendous quantities of freight being moved by the railways of the country, justify the equally great volume of money now changing hands in the nation's markets.

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

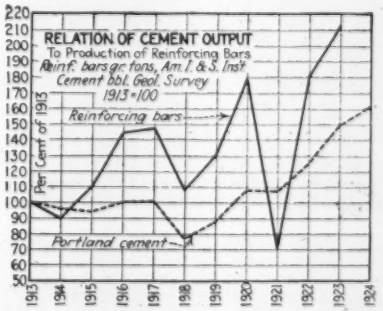
Mimimum costs observed are: $15,000 for waterworks and excavations, $25,000 for other public works, $40,000 for industrial and $150,000 for commercial buildings.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
April 9, 1925	$20,896,000	$27,522,000	$48,418,000
April 2, 1925	43,603,000	27,633,000	71,236,000
April 10, 1924	16,276,000	17,337,000	33,613,000
Heaviest Week Last Year			
May 8, 1924	26,370,000	38,829,000	65,199,000
This Year			
April 2, 1925	43,603,000	27,633,000	71,236,000
Jan. 1 to Date			
1925	245,018,000	347,737,000	592,755,000
1924	225,555,000	329,119,000	554,674,000

Output of Cement and Reinforcing Bars in Last Twelve Years

The relation between the production trends of cement and reinforcing bars is shown by the chart and the tabulation of Iron and Steel Institute figures. This subject was treated in the March 19 issue, p. 502, but the figures there given included bars other than reinforcing. The curves, however, have similar characteristics. The growth in the use of reinforced concrete is shown by the reinforcing-bar curve, which in 1923 stood 60 per cent above that of cement production. The 1924 bar figures will be available in May this year.



The following tabulation shows the annual output of iron and steel concrete bars compared with that of portland cement, from 1913 to 1924:

	Reinforcing Bars Gross Tons	Portland Cement Barrels
1913	319,670	92,097,000
1914	288,471	88,230,000
1915	353,408	85,915,000
1916	461,400	91,521,000
1917	471,184	92,814,000
1918	344,620	71,082,000
1919	419,021	80,778,000
1920	572,445	100,023,000
1921	227,228	98,842,000
1922	575,816	114,790,000
1923	680,867	137,460,000
1924	.....	148,859,000

Weekly Construction Market

PRICES of eighteen basic building materials, taken in the principal markets of the country during the current week, show a situation in which six of the items are higher than a week ago, six are on the decline and six hold firmly at present levels.

Materials showing firmness but without preceptible changes in prices, are: tile, wire nails, hemlock timbers, white oak lumber, glass and putty.

Quotations are higher for brick, concrete aggregates, reinforcing bars, yellow pine lath, yellow pine flooring and turpentine.

The declines occurred in lime, steel structurals, Douglas fir timbers, red cedar shingles, lead and linseed oil.

Paint demand is particularly active. The price situation in paint materials, however, is uneven. The recent downward trend in the non-ferrous metals' market has weakened the price of pig lead. This in turn has been passed on to red and white lead for the manufacture of paint. Raw linseed oil is $1.09 per gal. in 5 bbl. lots, f.o.b. New York, against $1.14, March 26, 1925. This is characteristic of the general situation in the linseed oil market. Turpentine is the one item to show an upward trend in price. Glass and putty are firm at present levels.

While there is an apparent slump in new building projects in the New York districts, reports from the West are of a more encouraging nature.

Notable gains are reported in permits issued in the St. Louis district, over those of the corresponding period last year. While Los Angeles shows a slight falling off in permits, practically every city in the Pacific Northwest reports record building totals for the month of March.

New York City is threatened with a strike among operators of hoisting machines and drivers of trucks used in hauling building materials. The trouble arose over the proposed unionization of the truck drivers, the action of the hoisting machine operators being purely sympathetic.

A strike of fifteen hoisting engineers and a walkout of carpenters on two big jobs are at present causing a partial crippling of building construction in St. Louis, Mo.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.15	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.60	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	3.38	3.00	3.25	3.87½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	53.2%	43%	56½%	54.25%	36%	44.7@55.5%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	52.60@53.60	56.00	—55.00	—46.20@48.70	55.50	62.00	+55.00	55.00	60.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.30	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	2.75	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	—1.00	1.40	2.00	2.75	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.75	1.75	2.50	2.15	3.00	+1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	61.00	+35.00	56.00	—29.00@39.00	39.75	—34.75	—27.00	25.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.50@2.75	1.45	1.85	2.66	1.35	2.70	1.60	2.80	10.50
Common brick, delivered, 1,000	17.00	10.50	12.10	12.00	+13.50@13.60	12.00	15.50	14.50	17.50
Hollow building tile, 4x12x12, per block	Not used	0808	.0941	.06	.07	085	.....	.11	.12
Hollow partition tile 4x12x12, per block	1162	0808	.0941	.06	.....	.085	.108	.11	.10
Linseed oil, raw, 5 bbl. lots, gal.	—1.09	—1.17	+1.35	—1.22	—1.18	—1.28	1.24	1.12	1.11
Common Labor									
Common labor, union, hour	75	30	.....	+.87½	.....	50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	25	.30@.50	.75	50@.55	.35@.50	.50	.50	.20@.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 50c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; lump finishing lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of April 2, the next on May 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand stone, gravel and lump lime per ton. Stone, lime and tile are delivered; sand, gravel and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.93). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.